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CLASSIFICATION UTILITY OF TEST COMPOSITES FROM THE ASVAB, CAT-ASVAB, AND ECAT BATTERIES

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13. ABSTRACT *(Maximum 200 words)*
The present study compares the classification efficiency of eight unique alternative combinations of individual tests from the Armed Services Vocational Aptitude Battery (ASVAB), Enhanced Computer-Administered Tests battery (ECAT), and Computerized Adaptive Testing version of the ASVAB (CAT-ASVAB). These candidate batteries differ in terms of abilities measured, mode of administration, and test time. In addition to examining classification efficiency, this study also evaluates the utility of each battery.

Findings: As expected, the eight candidate batteries differed significantly in terms of classification efficiency. Differences among the batteries accounted for about 50% of the total variation in efficiency. This translates into a 23% improvement in predicted performance from the least to the most effective of the eight batteries. In terms of relative contribution, it appears that the greatest improvement results from increasing the abilities measured, followed by mode of administration, with test time contributing the least.

Comparing paper-and-pencil with computerized batteries produced utilities (in net present value terms) that ranged from $6.8 to $11.6 billion. These were the four largest utilities in the study. Among the other two comparisons, one compared two paper-and-pencil tests and the other compared two computerized tests. The utilities for these amounted to $2.3 billion and $3.2 billion, respectively.

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Executive Summary

Background

Over the past decade, military personnel research organizations have designed and developed a number of computerized tests or test batteries to improve selection and classification decisions for enlisted personnel. Two of the most important of these batteries are the Computerized Adaptive Testing version of the Armed Services Vocational Aptitude Battery (CAT-ASVAB) and the Enhanced Computer-Administered Tests battery (ECAT).

Several studies have used these batteries to investigate gains in predictive validity for predicting school or job performance. However, these studies focus on differences in predictive validity and implicitly assume the use of a selection model which evaluates all applicants for a single job. They do not measure gains in efficiency due to considering personnel for a variety of assignments, i.e., personnel classification.

The present study compares the classification efficiency of eight unique alternative combinations of individual tests from the ASVAB, ECAT, and CAT-ASVAB. These candidate batteries differ in terms of abilities measured, mode of administration, and test time. In addition to examining classification efficiency, this study also evaluates the utility of each battery.

Hypotheses

The primary hypothesis of this study predicts that changes in abilities measured, mode of administration, and test time can increase the classification efficiency of eight specified test batteries. In addition, we tested six hypotheses that address comparisons between specified pairs of these batteries. The comparisons examine the effects of mode of administration and/or abilities measured on classification efficiency. For these six pairs, we hypothesized that both computerization and increases in battery complexity would increase efficiency. Since classification utility is a function of classification efficiency, improvements in efficiency should, in turn, lead to corresponding improvements in utility.

Approach

The following seven steps provide an overview of our approach to evaluate these candidate batteries: 1) First, we used analytic techniques to create validity and intercorrelation matrices for each candidate test battery. 2) From the matrices of each battery, we developed regression equations to predict performance in each school. 3) Next, we used these regression equations to compute predicted performance scores for members of several randomly selected applicant samples. 4) For each sample, we used these

scores to optimally assign a specified portion of applicants to schools. 5) We summed the individual predicted performance scores associated with the optimal assignment of each sample to compute a mean predicted performance score for each battery. 6) Next, we averaged the mean predicted performance scores (across samples) to obtain overall means for each test battery. 7) We used these results, based on 18 schools, to estimate the expected utility of each candidate battery for all military occupational specialties (MOSs).

Findings

As expected, the eight candidate batteries differed significantly in terms of classification efficiency. Differences among the batteries accounted for about 50% of the total variation in efficiency. This translates into a 23% improvement in predicted performance from the least to the most effective of the eight batteries. In terms of relative contribution, it appears that the greatest improvement results from increasing the abilities measured, followed by mode of administration, with test time contributing the least.

Evaluation of the paired comparisons also yielded statistically significant findings, supporting all six hypotheses. These six comparisons demonstrate the combined benefits of a computerized mode of administration and inclusion of additional measures.

Since all six comparisons produced significant differences, we computed the dollar-based utilities for all comparisons. The four hypotheses comparing paper-and-pencil with computerized batteries produced utilities (in net present value terms) that ranged from $6.8 to $11.6 billion. These were the four largest utilities in the study. Among the other two comparisons, one compared two paper-and-pencil tests and the other compared two computerized tests. The utilities for these amounted to $2.3 billion and $3.2 billion, respectively.

Conclusions

The results of the present study support the following conclusions:

1) Use of a computerized mode of administration and/or computer-adaptive tests increase classification efficiency and the

   concomitant classification utility over that of a paper and pencil mode of administration.

2) Inclusion of additional tests increase classification efficiency and, in turn, increase classification utility, over that of the basic ASVAB or CAT-ASVAB.

3) Although we did not specifically test the significance of manipulating test time among the candidate batteries, test time appears to increase classification efficiency and utility. However, this increase is small, relative to increases due to test computerization and expansion.

4) We did not compare an ASVAB (or CAT-ASVAB) alone to an ASVAB (or CAT-ASVAB) plus full ECAT battery, holding test time constant. Based on the comparisons we do make, it appears that the addition of ECAT to an ASVAB (or CAT-ASVAB) battery provides a substantial gain in classification efficiency.

5) Under the assignment conditions used in this study, using the CAT ASVAB plus full ECAT instead of using P&P ASVAB and three ECAT tests provided the largest gain in utility. In this comparison, we estimated the dollar value of the utility gain at about $11.6 billion or about 4.1% of the DoD expenditures for fiscal year 1992 (FY 92). Since DoD would accumulate these gains over several years, the present value of the average increment in cash flow would amount to about $504 million annually. This amounts to 0.178% of DoD expenditures for FY 92.

Recommendations

Based on our findings and conclusions, we recommended that future research should:

1) Develop procedures to construct test batteries and regression equations that will simultaneously maximize classification efficiency while minimizing adverse impact.

2) Evaluate the incremental classification efficiency of the existing ECAT battery over the existing ASVAB (or CAT-ASVAB) in order to identify improvements in personnel classification without spending additional time or funding on test development.

3) Develop procedures to include non-dollar job values to more adequately reflect the value DoD places on military jobs.

4) Conduct sensitivity analyses to investigate the cumulative impact that all the conservative assumptions have on the results of utility analyses.

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We would like to thank Dr. Phil Bobko and Dr. Fritz Drasgow, our consultants on this project, for their technical guidance and review of the research plan. We also wish to acknowledge Ms. Kathleen Moreno for serving as the Contracting Officer's Technical Representative for this project. We want to recognize Dr. Dan Segall for his creative solutions to seemingly insurmountable psychometric conundrums.

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Introduction

Background

Over the past decade, military personnel research organizations have designed and developed a number of computerized tests or test batteries to improve selection and classification decisions for enlisted personnel. The most prominent of these is CAT-ASVAB, a computerized, adaptive version of the Armed Services Vocational Aptitude Battery.

In addition to CAT-ASVAB, another important battery of computerized tests is the Enhanced Computer Administered Tests (ECAT) battery. The tests in this joint-service battery measure additional abilities which could augment tests included in ASVAB or CAT-ASVAB. (See Wolfe, Alderton, Larson, and Held, in press, for a description of the development of the ECAT battery.)

Several studies have investigated the gain in predictive validity resulting from using ECAT in addition to ASVAB for predicting school or job performance (e.g., Wolfe et al., in press). Abrahams, Pass, Kusulas, Cole, and Kieckhaefer (1993) summarize many of these studies and present their own results on the incremental validity of ECAT. Essentially, all of these studies show only small increments in predictive validity when averaging ECAT gains over a set of schools or jobs. The studies focus on differences in predictive validity, and implicitly assume the use of a selection model which evaluates all applicants for a single job. They do not measure gains in efficiency due to

considering personnel for a variety of assignments, that is, personnel classification.

Several theoretical papers demonstrate the importance of evaluating the classification efficiency of test batteries (Brogden, 1951, 1959; Horst, 1954). Brogden's (1959) classification model indicates that classification efficiency is a function of the following factors: (1) the validity of the predictor equations, (2) the intercorrelation of predicted criterion scores, (3) the selection ratio, or percent rejected, and (4) the number of possible assignment categories. Since the military does, in fact, evaluate candidates for a wide variety of occupational specialties, the military should also assess the benefits to classification efficiency that alternative tests could provide.

A number of studies have focused on the classification efficiency of the military's classification system. Johnson and Zeidner (1990) completed a series of reports and studies on the classification efficiency and utility of the ASVAB as well as the ASVAB augmented with new tests (including some ECAT tests) developed for Project A. They document the potential for substantially improving the classification efficiency and utility of the military personnel assignment (or utilization) system (Zeidner & Johnson, 1989a, 1989b; Johnson & Zeidner, 1990; Johnson, Zeidner, & Scholarios, 1990). Peterson, Oppler, and Rosse (1992) also investigated the differential validity of the ASVAB and ECAT tests.

Purpose

To date, no studies compare the classification utility of the unique alternative combinations of tests from the ASVAB, ECAT, and CAT-ASVAB described in the contract statement of work (SOW). These "candidate" or alternative batteries differ in various ways including abilities measured, and method of administration. The method of administration includes paper & pencil (P&P), computer-administered (with and without a response pedestal), and computer-adaptive. The types of abilities include verbal, math, spatial, perceptual, memory, and psychomotor. These differences, in the method of administration and abilities measured, permit systematic investigation of a number of hypotheses concerning the classification utility of alternative test combinations. The SOW presents these hypotheses as paired comparisons of alternative combinations (i.e., batteries) of tests which vary in terms of abilities measured and method of administration. In addition to these comparisons, the SOW also requires that we simultaneously determine the optimal allocation of total test battery time to individual tests to maximize classification efficiency.

Overview of the Study

To evaluate the classification utility of each alternate combination of tests, we performed three basic steps. In the first step, we generated optimal regression equations. The second step employed predicted performance, estimated from these equations to optimally assign individuals to technical schools. Finally, in the third step, we applied a utility index (SDy) to the assignment

solutions and compared the classification utility of alternate test batteries.

In the military, assignment to a technical school actually indicates assignment to an occupational specialty or job. Typically, there is a unique entry-level specialty associated with each school. In this study, we use the terms job, school, and occupational specialty interchangeably.

As in other research studies (e.g., Schmidt, Hunter, & Dunn, 1987), the present study employed methods which, given a fixed set of assignment quotas, assign individuals to maximize predicted performance. That is, we assigned each person to one job such that the sum of the predicted performance scores over all people in the assigned jobs is maximized. In practice, however, military assignment policies encompass a number of other factors (e.g., travel costs and EEO objectives) that constrain the possible assignments and the concomitant classification utility. For this reason, policy makers might consider the resulting utilities in this study as maximum possible values. Nevertheless, we assume that the use of maximum values would not affect the relative differences between the classification utilities observed for alternative batteries. In conducting the utility analyses in this study, we assumed that the proportional difference in the dollar benefit between alternate batteries would not change if put into operational use.

It is important to note that the results of this study alone are not intended to serve as the basis for specific changes to the

military's operational selection and classification system. This study's results provide an estimate of the potential relative gain achieved in classification utility by using test batteries other than the ASVAB. Such information is useful for determining the future direction of efforts to improve the military's selection and classification system. In summary, this report documents our evaluation of the relative classification utility of various test combinations that differ from the current ASVAB in terms of testing time, method of administration, and abilities measured.

Method

Before addressing the specific procedures involved in this study, the following seven steps summarize these procedures: 1) First, we used analytic techniques to create validity and intercorrelation matrices for each candidate test battery. 2) From the matrices of each battery, we developed regression equations to predict performance in each school. 3) Next, we used these regression equations to compute predicted performance scores for members of several randomly selected applicant samples. 4) For each sample, we used these scores to optimally assign a specified portion of applicants to schools. 5) We used the individual predicted performance scores, associated with the optimal assignment of each sample, to compute a mean predicted performance score for each battery. 6) Next, we averaged the mean predicted performance scores (across samples) to obtain overall means for each test battery. 7) Finally, we used these results, based on 18 schools, to estimate the expected utility of each candidate battery for all military occupational specialties (MOSs).

The first few sections below describe the test batteries we analyzed and the experimental design for the study. The next three sections, Derivation of Regression Equations, Assignment, and Assessment of Utility, address the specific procedures involved in each step.

Test Batteries

We evaluated the classification utility for alternative combinations of individual tests from each of the following

existing batteries: ASVAB, CAT-ASVAB, and ECAT. As indicated in the introduction, these three batteries differ in terms of method of administration and abilities measured. Table 1 (provided by Segall, 1993) displays the composition of the current ASVAB (denoted B_1) and CAT-ASVAB (denoted B_2) as well as three alternative batteries (B_3, B_4 and B_5). This table indicates the ability measured and the method of administration for each test. For example, the table displays a "p" to indicate a paper-and-pencil method of test administration for each test in B_1, the current ASVAB. Table 1 also indicates other methods of administration, including computer-adaptive and computer non-adaptive (with and without a response pedestal).

Insert Table 1 about here.

Descriptions of the five batteries in Table 1 follow (based on descriptions in Segall, 1993):

1. ASVAB (denoted B_1)

   This is a paper-and-pencil battery, which acts as a baseline to determine the effect of altering battery composition,

2. CAT-ASVAB (denoted B_2)

   This battery consists of the same 10 tests as in ASVAB, but presented in a computer-adaptive format. Two of the CAT-ASVAB tests, NO and CS are speeded tests and do not employ an adaptive format.

3. ASVAB + P&P-ECAT (denoted B_3)

This paper-and-pencil battery contains existing tests plus those paper-and-pencil tests included in the ECAT battery. Even though all ECAT tests are administered by computer, several are simply conventional paper-and-pencil tests administered on a computerized platform. This battery is intended to represent the best paper-and-pencil battery that can be constructed from existing tests.

4. CAT-ASVAB + Non-Pedestal-ECAT (denoted B_4)

This battery consists of CAT-ASVAB and ECAT tests which do not use a response pedestal (Thus excluding the two Tracking tests and Target Identification). This battery is intended to represent the best computerized battery that can be constructed from available computerized non-response pedestal tests.

5. CAT-ASVAB + All-ECAT (denoted B_5)

This battery contains CAT-ASVAB and all tests included in the ECAT battery (including those requiring a response pedestal). It represents the most comprehensive computerized battery that can be constructed from all CAT-ASVAB and ECAT tests.

The following references contain descriptions of the tests within each battery: ASVAB Working Group, 1980; Wolfe et al., in

press (ASVAB), Moreno and Segall, 1992 (CAT-ASVAB), Wolfe, et al., in press (ECAT).

Hypotheses

The contract (#N66001-90-D-9502, DO 7J16) SOW required several specific comparisons among the five test batteries. Below, we present these specific comparisons (slightly modified from the SOW for clarification). In all comparisons, the total test completion time is optimally distributed among the individual tests to maximize the differential validity of each test combination.

> 4.4.1 What is the loss in classification utility if a shortened P&P-ASVAB is used in place of CAT-ASVAB? (B_1 vs B_2)
>
> Assume that the P&P-ASVAB completion time is shortened to match CAT-ASVAB. There are likely to be gains in processing efficiency associated with a shortened battery. One question likely to arise is: Why not achieve these gains by just shortening the P&P-ASVAB, rather than implementing CAT-ASVAB? This comparison will demonstrate the loss in utility.
>
> 4.4.2 Assuming that 2.25 hours (135 minutes), on the average, are available for testing, how does the utility of the best P&P battery compare with that of the best computerized non-pedestal battery? (B_3 vs B_4)

Assume that tests can be selected from the ECAT battery to supplement ASVAB subtests. However there are two restrictions. First, for the P&P battery, only those ECAT tests that can be administered in P&P format are considered for inclusion. Second, supplementing the computerized battery, only computerized non-pedestal ECAT tests are considered for inclusion.

4.4.3 Assuming that 3 hours (180 minutes), on the average, are available for testing, how does the utility of the current P&P-ASVAB compare with that of the best revised P&P battery? (B_1 vs B_3)

For the best revised P&P battery, only those ECAT tests that can be administered in P&P format are considered for inclusion. This best P&P battery should incorporate optimal individual test lengths.

4.4.4 Assuming that 3 hours (180 minutes), on the average, are available for testing, how does the utility of the best P&P battery compare with that of the best computerized non-pedestal battery? (B_3 vs B_4)

To supplement the ASVAB P&P subtests and create the best P&P battery, we include only

those ECAT tests that can be administered in P&P format. For the best computerized non-pedestal battery, we supplement the CAT-ASVAB with only those ECAT tests administered without a response pedestal. Both batteries, computerized and P&P, should incorporate optimal individual test lengths.

4.4.5 Assuming that 3 hours (180 minutes), on the average, are available for testing, how does the utility of the best computerized non-pedestal battery compare with that of the best computerized full battery? (B_4 vs B_5)

This comparison will assess the gain in utility attributable to including those tests that require a response pedestal. Both computerized batteries should incorporate optimal individual test lengths.

4.4.6 Assuming that 3 hours (180 minutes), on the average, are available for testing, how does the utility of the best P&P battery compare with that of the best computerized full battery? (B_3 vs B_5)

For the best P&P battery, only those ECAT tests that can be administered in P&P format are considered for inclusion. For the best computerized pedestal and non-pedestal

battery, all ECAT tests are considered possible for inclusion. Both batteries, computerized and P&P, should incorporate optimal individual test lengths.

The research questions above involve the five test batteries, B_1 through B_5, with three of the batteries (B_1, B_3, and B_4) evaluated under two different time limits. Since three of the five batteries require two different completion time limits, there were, in effect, eight candidate batteries or "testing conditions". Table 2 shows these eight testing conditions (A_1 through A_8) with their corresponding test battery and time limit. For example, in this table, A_1 involves a specific battery (B_1) with a time limit of 100 minutes.

Insert Table 2 about here.

The SOW requires six specific comparisons, or contrasts, among these candidate batteries. Table 3 shows these comparisons by their SOW task number. The column "Expected Completion Time" indicates, in minutes, the experimental variation in completion time allowed for each of these batteries. For example, the first row of the table, task 4.4.1, indicates a contrast between an ASVAB (A_1) and CAT-ASVAB (A_2) with an expected completion time equivalent to 100 minutes.

Insert Table 3 about here.

We evaluated these six contrasts, or planned comparisons, among these eight testing conditions. Table 4 presents the Testing Condition factor with eight levels, A_1 through A_8, and the coefficients specifying the comparisons. Although these contrasts are not orthogonal, they are planned comparisons. Each comparison in Table 4 involves the difference between classification efficiency for a specific pair of candidate batteries. Because increases in classification efficiency produce concomitant gains in classification utility, our hypotheses below assume that, for each paired comparison, the battery showing more classification efficiency will also show corresponding gains in utility.

Insert Table 4 about here.

In Table 4, a "-1" indicates the treatment which should have a lower mean classification efficiency. Likewise, a "1" indicates the treatment we expect to have a higher mean efficiency. The hypotheses for the six planned comparisons follow:

4.4.1 - A_1 should have lower classification efficiency than A_2. Shortening A_1 would lower its reliability, and consequently its validity; and ultimately, its efficiency.

4.4.2 - A_3 should have lower efficiency than A_4. A_4 has all the tests in A_3, plus three additional tests. A_4 is also a

computerized test. The three additional tests and the computerized mode of administration could only increase classification efficiency.

4.4.3 - We expect A_5 to have lower efficiency than A_6. A_6 has three additional tests, which could only increase efficiency.

4.4.4 - A_6 should have lower efficiency than A_7. As in 4.4.2, A_7 is computerized and has all the tests of A_6 plus three additional tests. The computerized mode and the additional three tests could only increase the efficiency of A_7 over that of A_6.

4.4.5 - Here, we expect A_7 to have lower efficiency than A_8. A_8 has all the tests of A_7 plus three additional tests, which could only raise the efficiency of A_8 over that of A_7.

4.4.6 - Here, A_6 should have lower efficiency than A_8. A_8 is computerized and has all the tests in A_6 plus six additional tests. These differences could only increase the efficiency of A_8.

As indicated earlier, we estimated the classification efficiency and utility of each battery using three basic steps. In the first step, we generated optimal regression equations. The second step employed predicted performance, estimated from these equations, to optimally assign individuals. Finally, the third step involved applying a utility index (SDy) to the assignment solutions and comparing the classification utility of alternate test batteries.

Experimental Design

For each of the eight candidate batteries, we created multiple samples (i.e., replications) for classification into one of the

study's assignment categories. The Assignment section of this report describes those procedures. In the present study, the assignment categories are the 18 technical training schools described in Abrahams et al. (1993). The results from these 18 possible assignments enabled us to estimate classification efficiency and utility for each candidate battery (testing condition). In addition, we extrapolated the efficiency and utility estimates from the limited number (18) of assignment categories to the actual number (622) of existing MOSs. Although Brogden (1959) demonstrates that classification efficiency increases with the number of assignments, his analysis is limited to 15 assignment categories. To account for the expected increase in efficiency from classifying individuals into 622 MOSs, we developed a function based on Brogden's procedures and assumptions. This function permits extrapolation of classification efficiency to several hundred assignment categories. Before applying this function, for each candidate battery, we computed interim utility estimates for all 622 assignment categories. To compute these estimates, we used the mean predicted performances (MPPs) from the 18 schools. (A later section of this report describes these procedures in detail.) Finally, we applied the Brogden-based adjustment to these interim utility estimates to compute our final utility estimates for each battery.

The experimental design appropriate for evaluating all of these comparisons is a randomized block design with eight levels of one treatment factor (one for each testing condition). This design

permits the simultaneous evaluation of all testing conditions (Edwards, 1972).

Table 5 presents this experimental design, in which A is the Testing Condition Factor (previously defined), and Replications (R) are the blocks. Within each replication, or block, exactly the same individuals were available for assignment within each of the treatment conditions. Edwards (1972) discusses this design in some detail as well as suitable tests of significance. McNemar (1962) discusses the appropriate significance test for planned contrasts.

Insert Table 5 about here.

For each of the eight testing conditions, we optimally assigned the same 100 individuals in each replication. We assigned each subject to one of the 18 schools. The assignment algorithm filled quotas to optimize predicted performance for the 18 schools.

As the subscripts in Table 5 illustrate, we used the same 100 individuals, within each replication, for assignment in each of the testing conditions. We conducted eight replications for each treatment condition. The Assignment section describes the procedure we used to determine the size of the simulated applicant samples and the specification of the selection ratio.

Derivation of Regression Equations

Data

For each candidate test battery, we generated the appropriate intercorrelation and validity matrix. These matrices include the

relevant tests for each candidate battery and reflect the optimal allocation of total test administration time to each component test. Ideally, generating all the necessary matrices would require a sample of subjects who completed all three batteries and were then assigned to a variety of treatments (e.g., technical schools or occupational specialties). Unfortunately, data were only available for the ASVAB and ECAT batteries (see Abrahams et al., 1993).

The basic data in the Abrahams et al. (1993) study are ASVAB and ECAT test scores and criteria for 9,038 enlisted recruits assigned to 18 technical schools. The criterion measure for most of the schools is Final School Grade (FSG). Table 6 presents a listing of the 18 schools. For a complete description of all the basic data, see Abrahams et al.

Insert Table 6 about here.

Since CAT-ASVAB scores were not available for the 18 school samples, we used analytical methods to estimate the CAT-ASVAB test scores. We based the estimated CAT-ASVAB scores on ASVAB true scores, under the assumption that corresponding ASVAB and CAT-ASVAB tests measure the same abilities. Moreno and Segall (Submitted for publication) support this assumption with results showing a virtually perfect intercorrelation between true scores of corresponding tests in CAT-ASVAB and ASVAB.

Corrections to ASVAB and ECAT Intercorrelations and Validities

This section describes the data matrices and procedural steps required to generate corrected ASVAB and ECAT intercorrelation and validity matrices.

Population #1 Matrix. This matrix is from the 1991 DoD population of applicants that Abrahams et al. (1993) used in their study. It contains the means, standard deviations, and intercorrelations for the ASVAB tests in the applicant population. We refer to this intercorrelation matrix as <u>Population #1 Matrix</u>. This matrix is in Table A-1 of Appendix A.

School Sample Data Matrices. Our school sample data matrices contain the range restricted intercorrelations of ASVAB, ECAT, and the criterion, usually FSG, together with their means and standard deviations, for each of the 18 school samples from the Abrahams et al. (1993) study. We refer to these as the <u>School Sample Data Matrices</u>. Tables A-2 through A-19 of Appendix A contain these 18 matrices.

Combined Schools Predictor Matrix. We combined the ASVAB and ECAT intercorrelation data for all 18 schools, yielding a combined schools predictor matrix of 9038 subjects. This matrix contains the restricted means, standard deviations, and intercorrelations for the 10 ASVAB and 9 ECAT tests. We refer to this matrix as the <u>Combined Schools Predictor Matrix</u>. This matrix is in Table A-20 of Appendix A.

Population #2 Matrix. Using the Population #1 Matrix as the population matrix and the Combined Schools Predictor Matrix as the

restricted matrix, we applied the correction for multivariate restriction in range (Lawley, 1943) to estimate the population intercorrelations, means, and standard deviations for the ASVAB and ECAT tests. The resulting matrix was a combined predictor population matrix, which we refer to as <u>Population #2 Matrix</u>. Table A-21 of Appendix A contains this matrix.

Corrected School Validity Matrices. Using the Population #2 Matrix as the population matrix, and the 18 individual School Sample Data Matrices as the restricted matrices, we applied the correction for multivariate restriction in range (Lawley, 1943) to estimate population FSG validities, plus means and standard deviations, for each school. While this correction also produced predictor intercorrelations, as expected, they were identical for each of the 18 schools and to those in the Population #2 Matrix, which is in Table A-21 of Appendix A. We refer to these matrices as the <u>Corrected School Validity Matrices</u>.

Matrix of Fully Corrected School Validities. As mentioned in the preceding paragraph, each of the Corrected School Validity Matrices for the 18 schools were identical except for the last column of corrected validities, which differ for each school. We created a new matrix from these 18 columns of validities, making a new matrix of 18 rows and 19 columns. Each row of the matrix corresponds to one of the 18 schools, and each column refers to one of the 19 tests. Thus, the *i*th row contains the corrected validities for the 19 tests in the *i*th school. The validities in this matrix were corrected for criterion unreliability. We call

this matrix the Matrix of Fully Corrected School Validities. Table A-22 of Appendix A contains this matrix.

Of the matrices above, the following three play a fundamental role in subsequent analysis:

1. Population #1 Matrix; Table A-1, Appendix A,
2. Population #2 Matrix; Table A-21, Appendix A, and
3. Matrix of Fully Corrected School Validities; Table A-22, Appendix A.

Reliability Estimates

In addition to test intercorrelations and validities, for subsequent analyses, we also needed test reliability estimates of the three batteries for the applicant population. This section discusses how we used the corrected matrices (Population Matrix #1 and #2) to estimate these reliabilities for the applicant population.

ASVAB Reliabilities. We obtained reliability data from a study (Moreno & Segall, submitted for publication) in which a group of Navy recruits completed two non-operational forms of the ASVAB. Each recruit in the sample also completed the operational ASVAB prior to enlistment. The intercorrelations among the three ASVAB forms, together with their means and standard deviations, constitute the ASVAB Reliability Matrix.

We used the Population #1 Matrix as the unrestricted matrix and the ASVAB Reliability Matrix as the restricted matrix. We applied the correction for multivariate restriction in range to yield the population means, standard deviations and

intercorrelations for the operational ASVAB (the explicit selection variables) and the two non-operational ASVAB forms (the implicit selection variables). This correction yielded the ASVAB Corrected Reliability Matrix.

Originally, we planned to use the correlation between corresponding tests on the two non-operational ASVAB forms to represent the subtest reliabilities. However, preliminary analysis revealed the second subtest reliabilities were too low, having been degraded by various factors (see Moreno & Segall, submitted for publication). Relying on the structural analysis of Moreno and Segall, we used the reliability of the first-administered non-operational ASVAB form to estimate the subtest reliabilities (i.e., ASVAB Form 9B). Table 4 in Moreno and Segall presents these reliabilities. Using the ASVAB Form 9B reliabilities, together with the subtest standard deviations from the ASVAB Reliability Matrix and the ASVAB Corrected Reliability Matrix, we estimated the population subtest reliabilities using the following equation from Kelley (1921). This equation assumes equality of error variance in the population and the sample;

$$R_{ii} = 1-(\frac{s_i}{S_i})(1-r_{ii}); \qquad (1)$$

where the capital R and S refer to the Population #2 Matrix reliability and standard deviation, respectively, and the lower case r and s refer to the sample restricted reliability and standard deviation, respectively, for test i. Table B-1 in

Appendix B presents the restricted and unrestricted standard deviations and reliabilities.

ECAT Reliabilities. Larson and Alderton (1992) conducted a test-retest study of the reliability of the ECAT. The nine ECAT tests were administered twice to a sample of 313 High School and Junior College students, with a retest interval of four to five weeks. Larson and Alderton provide the standard deviations and reliabilities of the nine ECAT tests in this sample. We corrected these reliabilities in the student sample for restriction in range by substituting the estimated population ECAT standard deviations from our Population #2 Matrix, together with the ECAT sample standard deviations and reliabilities, into Kelley's (1921) equation, presented above as our equation (1). Table B-2 in Appendix B presents the sample and population ECAT standard deviations and test-retest reliabilities.

CAT-ASVAB Reliabilities. The eight power tests in the CAT-ASVAB are administered in a tailored testing manner, so that each successive item is chosen to be most appropriate to the examinee's estimated ability, based on their performance on previous items. As a result, the gain in reliability expected from each successive item is greater than would be expected using ordinary paper-and-pencil methods. In this way, the CAT-ASVAB power tests are able to achieve greater reliability with fewer items and in less time than their paper-and-pencil ASVAB counterparts. However, because of the adaptive nature of the testing, the conventional Spearman-Brown formulas are not appropriate for estimating gains in reliability

due to lengthening the tests. Consequently, the CAT-ASVAB requires a reliability function appropriate for adaptive tests.

Segall (1993) developed an equation for estimating the CAT-ASVAB reliability function for the power tests. This equation is:

$$p_{ii}^{(4)}(t_i) = 1 - [1 + u_i(n_{o_i} \times \frac{t_i}{t_{o_i}^{(4)}})^{v_i}]^{-\frac{1}{w_i}} \qquad (2)$$

in which:

$p_{ii}^{(4)}(t_i)$ is the reliability of the *i*th test at its revised expected completion time,

t_i is the expected completion time of the *i*th test,

$n_{o(i)}$ is the number of items in the original *i*th test,

$t_{o(i)}$ is the expected completion time of the original *i*th test, and

u_i, v_i, and w_i are the reliability functions parameters for test i.

Table C-1 presents the above constants (derived by Segall, 1994) for each of the CAT-ASVAB power tests.

Auto/Shop Information (AS) Reliabilities. While the ASVAB measures Auto/Shop Information with a single subtest, AS, the CAT-ASVAB measures Auto Information (AI) and Shop Information (SI) separately. Segall (1994) combined the AI and SI tests in a way to be comparable to the ASVAB AS subtest, and provided the constants to enter this combination into his equation 5.11 (our equation (2) above). Table C-1 includes these constants.

Estimating CAT-ASVAB Intercorrelations

As indicated earlier, CAT-ASVAB test scores were not available for our samples. Consequently, we estimated CAT-ASVAB intercorrelations and validities from the ASVAB data using the procedures in Segall (1993). Below, we describe these procedures, which require ASVAB intercorrelations and reliabilities and CAT-ASVAB reliabilities.

The Population #2 Matrix contains the population intercorrelations for the paper-and-pencil ASVAB. We obtained the reliabilities of the P&P-ASVAB subtests from the ASVAB Corrected Reliability Matrix, as described earlier. We refer to the *i*th P&P-ASVAB test reliability as $r_{p(i)}$.

We determined the CAT-ASVAB reliabilities at their original lengths from the reliability functions provided by Segall (1994). We refer to the reliability of the *i*th CAT-ASVAB subtest as $r_{c(i)}$.

We derived a weight for each ASVAB test, which is the square root of the ratio of the two reliabilities:

$$W_i = \sqrt{\frac{r_{c(i)}}{r_{p(i)}}}$$

We obtained the CAT-ASVAB intercorrelations from the P&P-ASVAB intercorrelations as follows:

$$r_{c(i,j)} = r_{p(i,j)} (w_i) (w_j).$$

The CAT-ASVAB reliabilities at their original lengths can be obtained by entering the original expected completion times for the tests in equation (2). Table C-2 presents the reliabilities and

weights for the eight CAT-ASVAB power tests. Table C-3 shows the estimated CAT-ASVAB intercorrelations.

Estimating CAT-ASVAB Validities

The Matrix of Fully Corrected School Validities contains the population validities for the i = 10 P&P-ASVAB tests in each of k = 18 schools. We obtained the population validities for the i = 10 CAT-ASVAB counterpart tests using the equation:

$$r_{c(i,k)} = r_{p(i,k)} \ (w_i),$$

where the w_i values are the same as those defined in the section above. Table C-4 presents these estimated CAT-ASVAB validities.

Parenthetically, the same general procedure can be used to estimate the intercorrelations and validities of any battery, where the W_i values are defined as:

$$W_i = \sqrt{\frac{\textit{new ith test reliability}}{\textit{original ith test reliability}}}$$

Individual Test Completion Times

Subsequent analyses involving optimal allocation of total battery time required completion times for the individual tests in each battery. Table D-1 in Appendix D presents these times. The following sections describe the derivations of the table entries.

ASVAB. Because of the lock-step nature of the P&P-ASVAB, the test time is the same for everyone and corresponds to the times allotted to each of the tests. Table 1 in Wolfe, Alderton, and Larson (in review), provides these time limits.

ECAT. For computer administered tests, expected completion time is taken as the average completion time among examinees. The Abrahams et al. (1993) study provided estimates of the mean ECAT test times. Using Lawley's (1943) multivariate correction, we obtained estimates of applicants' ECAT mean test times based on the means observed in the school sample.

Three of the ECAT subtests, FR, AO, and SO, can be administered directly in paper-and-pencil form. Using data from the Abrahams et al. (1993) study, we created logarithms of the FR, AO, and SO subtest times. We used these logarithms, together with the selectee ASVAB scores, to construct the sample matrix, and we used the Population #1 Matrix as the population matrix. We applied Lawley's (1943) procedure to these matrices to obtain estimated population means and standard deviations for testing times. We then converted the 95th percentile of the log times to actual times. We used these times as the time limits for the paper and pencil FR, AO, and SO ECAT subtests. Table D-1 Presents completion times for all ECAT tests.

CAT-ASVAB. Because CAT-ASVAB is an adaptive battery, individuals can proceed at their own pace, avoiding the lock-step requirement of the same testing time for everyone. Consequently, we used the average testing times (presented in Segall, 1993, Table 5.8) to determine the required testing time for each subtest. Segall provided the population expected completion times for the CAT-ASVAB. Table D-1 in Appendix D lists these completion times.

Optimal Allocation of Total Battery Time

Recall that all of the battery comparisons require a method to determine the optimal allocation of test time to individual tests that maximize differential validity. Though several methods have been proposed for selecting tests for inclusion in a differential aptitude battery, only Horst and MacEwan (1957) provide an analytical method for determining optimal allocation of total test administration time to the individual tests in a battery while maximizing differential validity. Extensive studies by Johnson et al. (1990) failed to reveal any procedure that resulted in assignments superior to those derived using Horst's (1956) methods. For this reason, we employed Horst's procedures.

Essentially, this procedure (Horst, 1956) uses population-corrected validity and reliability information to simultaneously modify all subtest lengths for a fixed total time, with the objective of identifying the set of test lengths that maximize differential prediction across assignments. Since this is an iterative procedure, it is more efficient if the time limit of the battery for the initial matrix is approximately equal to the desired total time at the beginning of the iterative process. We used Horst's (1956) Phi index to measure the magnitude of differential prediction at each iteration.

To implement this process, we divided Horst's (1956) procedure into two programs. The first, HORST-L1.BAS, generates an initial matrix of validities and intercorrelations based on a constant proportionate reduction in the length of each test as a first

approximation. Appendix E illustrates the procedure for proportionate reduction to .8 of original test time. The second program, HORST-L2.BAS, then uses these data to generate approximations 2 through 20. We thought this would be a sufficient number of iterations for just about any problem. In one instance, when we needed more iterations, we used the validities and intercorrelations from the 20th iteration as program input to generate a second set of 20 iterations. This process could be repeated any number of times. However, after 40 iterations, the test lengths had fully stabilized.

We first applied the Horst (1956) procedure to the P&P-ASVAB with 100 minutes testing time, and then to the P&P-ASVAB with 180 minutes testing time. Tables F-1 and F-2 of Appendix F present the optimal test times, intercorrelations, and validities for the P&P-ASVAB with 100 minutes total testing time. Tables F-3 and F-4 of Appendix F present these same statistics for the P&P-ASVAB with 180 minutes total testing time.

Horst's (1956) method for determining optimal test length for differential prediction is based on the relation between error variance and test length when the Spearman-Brown formula (Guilford, 1965) is appropriate. With Computer Adaptive Tests, the Spearman-Brown formula is not appropriate; so direct application of Horst's procedure will yield incorrect results. Therefore, we modified the Horst procedure to incorporate the non-linear reliability functions described earlier for the CAT-ASVAB.

We then applied the Horst (1956) procedure to the remaining testing conditions. Table 7 provides the resulting optimal test times for each of these eight conditions. Appendix F (Tables F-5 through F-20) contains the intercorrelations and validity matrices, corresponding to the optimal test times, for all eight testing conditions. We used these matrices to generate standard regression equations for predicting school performance.

Insert Table 7 about here.

Table 8 presents the original test lengths and the proportionately increased test lengths for a 100-minute CAT-ASVAB battery. One can compare the test times in Table 8 with those in column A_2 of Table 7 to see the effects of the Horst (1956) procedure on optimal allocation of test time. The results for this CAT-ASVAB battery show WK and EI as the two tests with the largest proportional increases in test time. Furthermore, these tables show AR and CS as the two tests yielding the greatest decrease.

Insert Table 8 about here.

Assignment

Deriving Simulated Test Scores and Expected Criterion Scores

The research design we used required replication on several samples. To create multiple samples with test scores on all three test batteries, we created synthetic subjects randomly drawn from

a multivariate normal distribution. We created this multivariate normal distribution from the Population #2 Matrix, after correcting for attenuation.

Insert Table 9 about here.

We corrected only 19 of the 29 tests (i.e., 10 ASVAB, and 9 ECAT tests) for attenuation. (The ten CAT-ASVAB scores were derived from the simulated ASVAB scores generated by the procedures described in this section.) Table 9 presents the resulting true score intercorrelation matrix. We factor analyzed this true score matrix using the principal components method. We used the first 16 of the 18 factors shown in Table G-1 of Appendix G. Table G-2 of Appendix G presents the factor loadings for the 19 tests. The factor analysis yielded a set of 16 factor loadings for each test in the battery. For any simulated individual, we drew 16 random normal deviates, standing for the 16 factors, respectively. Each individual's simulated score on any test is the sum of the products of the normal deviates multiplied by their respective factor loadings for that test (Guilford, 1965). We refer to these test scores as the individual's "true scores", since we statistically eliminated all error variance. These "true scores", which we attenuated by the appropriate reliability, formed the basis for generating "observed scores" for any specific battery in a contrast of interest.

To generate "observed scores" for the tests in any specific battery, we drew one additional random normal deviate for each test in the battery to represent the test's "error" component. As the following formula illustrates, we computed the "observed score" (X_o) for any test by multiplying the previously computed "true score" (X_t) by the square root of the test's reliability (r_{xx}), plus the "error component" (e_x) random normal deviate for that test, multiplied by the square root of one minus the test's reliability at the test's optimal length.

$$X_o = X_t\sqrt{r_{xx}} + e_x\sqrt{1-r_{xx}}$$

Similarly, we created CAT-ASVAB scores from the corresponding ASVAB true scores and the CAT-ASVAB reliabilities using the same equation. Then, we computed the expected criterion scores for each individual by applying the previously developed least-squares regression equations to the individual's "observed scores". These scores are Z scores (mean = 0, S.D. = 1), standardized using the 1991 applicant data.

Using this method, we created eight applicant samples, each containing 100 subjects. From each applicant sample, we assigned that number of applicants to entry level schools to correspond to the proportion of 1992 applicants assigned to entry level schools. We set the individual school quotas to match the actual relative proportions assigned to the 18 schools in FY92. Table 10 contains the estimated school quotas we used for assignment simulations.

Insert Table 10 about here.

Estimating Individual Marginal Utility in Dollars

The regression equations described in the previous sections yield predicted performance (PP) scores for individuals. These scores alone do not reflect the dollar value of various levels of performance in various assignments. At this point, the original research plan called for developing estimates of individual marginal utility in dollars. We planned to estimate individual level utility by considering "per person" dollar value within each job. After collecting financial data reflecting the dollar value of various military jobs, we found evidence that the economic values observed for military jobs may not adequately reflect their perceived value to the military. The rest of this section presents our observations and explains why we altered our research plan to enter only the PP scores into the assignment algorithm.

Based on techniques described in a later section, Table 11 presents an estimated value called "dollar job value" for 17 of the 18 occupational specialties we included in this study. Our validity study investigated two training subspecialties within the Army 11H MOS, but the DMDC financial data could provide only one job value for both subspecialties. Consequently, we have only 17 unique dollar job values. (Please see the section entitled "Assessment of Utility" for an explanation of how we computed the dollar value of jobs.) Private sector salary administrators might

expect that a job in a higher complexity category should have two or three times the value of a job in a lower complexity category. (A later section of this report presents evidence supporting this expectation.) The data from our sample, however, show that the average ($130,921.86) medium complexity jobs show only about 25% more value than average ($104,906.60) for low complexity jobs. Also, practically no difference exists (and not in the predicted direction) on mean job value between the two highest job complexity categories.

Insert Table 11 about here.

The lack of meaningful differences in the dollar job values by complexity category suggests that financial data alone might not adequately reflect job value for military jobs. To examine this possibility, we used data contained in Bobko and Donnelly (1988). They used a ratio scale to collect utility ratings from field grade Army officers for 19 Army MOSs. Using the financial data we collected, we located 15 of these 19 MOSs in our database and computed their economic-based job values. Then, we correlated those job values with the ratings in Bobko and Donnelly for the 50th performance percentile. The resulting correlation (-.196) was not in the predicted direction and not significantly different from zero.

Table 12 presents further information supporting the disparity between military and civilian pay by job complexity category. To

create Table 12, we used data from Hunter, Schmidt, and Judiesch (1990) to identify several civilian jobs in the same job complexity categories as our military jobs. For the civilian jobs we identified in this way, we obtained mean salaries from a local (Southern California) salary survey. Our Table 12 presents mean monthly salaries by job and by job complexity category for the military and civilian jobs. We computed the military mean salaries from data provided by DMDC.

Insert Table 12 about here.

Inspection of Table 12 shows that average salaries for civilians in the lowest category equal about 98% of the military salaries in that category. The similarity in pay structure, however, appears to stop there. The average civilian salary in the middle complexity category is about 94% greater than the salary of the lowest complexity category, while the average military salary is only about 25% larger. Looking at the top two civilian categories, we find that average salaries in the highest category are about 2.7 times the average salaries in the middle category. Looking at the corresponding categories for two military jobs, we find that average salaries in the first category are slightly less than the average salaries in the middle category.

These findings support the contention that the military places value on their jobs independent of economic value reflected by what it pays for those jobs. Recognizing this, we decided NOT to base

assignments on predicted utility but instead on predicted performance. By basing assignments only on predicted performance, we could still estimate utilities after optimal assignment from increments in predicted performance. In addition, others could apply alternative measures of utility to these same mean performance estimates available from each candidate battery. By excluding utility from the assignments, we exercised care NOT to over emphasize the importance of the dollar value of jobs to the military.

Next, we compared the job values by complexity category for the 16 MOSs in Bobko and Donnelly (1988). Table 13 presents these data in the same format we used to show such data from this study in Table 11. The mean job value for complexity category 2 is higher than the value for category 3 in both studies (about 25% higher in this study and about 17% higher in Bobko and Donnelly). This offers some support that the dollar values we plan to use later in this study reflect the expected relationship to complexity.

We point out, however, that the combination of these findings suggests the need to eventually develop a concept of value for military jobs that considers factors beyond dollar value. For this study, then, these economic job values will likely underestimate the true job value as perceived by the military. Therefore, these economic job values will likely provide conservative estimates and underestimate the value of whatever gains are realized from an improved selection system.

Insert Table 13 about here.

Based on our findings regarding the economic value of jobs in the military, we used only PP scores as input for the assignment procedure. (We described the procedures to compute the PP scores earlier in the section entitled "Derivation of Regression Equations".) For each case, we computed the scores for every school in our sample as a matrix of PP. This matrix served as the input for the assignment procedure described next.

Assignment Algorithm

We used software provided by NPRDC to optimally assign individuals to schools. This software is based on the Ford-Fulkerson transportation algorithm (Ford & Fulkerson, 1956). Using the PP scores described above, this software assigned individuals to maximize the sum of the PP values across individuals' school assignments. Our SOW does not require us to incorporate policies included in the military's operational assignment system. Incorporating such policies might increase the difficulty of interpreting the results of our comparisons. We assume their exclusion did not affect the relative difference between batteries.

The input to the program included: the number of assignment categories (i.e., schools), the total number of individuals to be assigned, the quota for each school, and a predicted performance score for each school for every person. For each contrast, we

applied the Ford-Fulkerson procedure to assign eight samples of individuals to schools.

An additional concern in generalizing from our sample of 18 schools to all military jobs is the impact of the number of possible assignments on classification utility. As Brogden (1959) indicates:

> The number of jobs is highly important to efficiency of classification. With other factors constant, the allocation average will double in going from 2 to 5 jobs and triple in going from 2 to 13 jobs. (p. 189)

Although the military assigns enlisted personnel to over 500 entry-level occupational specialties, the data for the present study was limited to 18 specialties. This limitation required extrapolation of the classification utility observed for the 18 specialties to the utility for all specialties. Using the results of varying the number of possible assignments (see Table 5), we generated a function on which to base this extrapolation.

Assessment of Utility

Hypothesis testing during this project compared the effect of using one selection battery or approach versus another on the resulting mean PP scores. Where hypothesis testing produced significant differences, we used the procedures below to assess the dollar utility of those differences.

Brogden (1946, 1949) developed the basic formula for the marginal utility per selectee (i.e., the mean):

$$\overline{Y}_s - \mu_y = r_{xy} SD_y \overline{Z}_{x_s}$$

or,

$$\Delta U_s = r_{xy} SD_y Z_{x_s} \tag{1}$$

where:

- $\overline{Y}_s$ is the mean predicted value of individual performance on the job expressed in dollars,
- μ_y (mean output) is the population mean of **individual** job performance in dollars (or for individuals selected randomly),
- ΔU_s is the mean marginal utility per selectee,
- r_{xy} is the population correlation between ability and performance (for the applicant population),
- SD_y is the standard deviation of job performance in dollars in the applicant population, and
- $\overline{Z}_{x_s}$ is the mean predictor score expressed in standard score units (mean 0, standard deviation 1) of those selected.

It follows that the marginal utility for a particular selectee (ΔU_s) is given by:

$$\Delta U_s = r_{xy} SD_y Z_{x_s} \tag{2}$$

Finally, the total marginal utility (ΔU_{Total}) is the mean gain per selectee from equation (1) times the number of people selected, N_s:

$$\Delta U_{Total} = N_s r_{xy} SD_y \overline{Z}_{x_s} \tag{3}$$

or,

$$\Delta U_{Total} = N_s \, \Delta \bar{U}_s \tag{4}$$

Notice that formulas (3) and (4) resemble those for computing a sum of X based on knowing the mean X score and the total N (i.e., $\Sigma X = N * \bar{X}$). Just as the ΣX represents the accumulated value of all X scores, the ΔU_{Total} accumulates marginal utilities over all selectees (ΔU_s). In each case, the formulas accomplish this by multiplying the mean value by the number of observations accumulated.

Also notice that the formulas presented above include the value of the incremental performance above baseline (random selection), but do not include costs such as those associated with testing. In their research, Schmidt et al. (1987) ignore the cost of testing as "negligible relative to utility gains". The purpose of this study is different in that it compares the utility of various batteries. Therefore, we considered reducing ΔU by the cost of testing. Also, utility analysts (e.g., Cascio, 1989; Boudreau & Berger, 1985) typically prefer to include terms in the equation to adjust ΔU_{Total} for other costs such as those for attrition, recruiting, or processing efficiency. Later in this section, we explain why we did not need to adjust ΔU for such costs in this study. At that time, we will revisit these issues together with the issues of net present value.

Essentially, equation (2) describes the components of the ΔU_s term for each selectee. Previous sections described how we

obtained predicted criterion scores (or predicted performance, PP, scores) for use in assignment. These scores are conceptually equivalent to the product of r_{xy} and Z_x, two of the components in equation (2). In the first subsection below, we describe the procedures we used to compute or estimate the remaining component, SD_y, for each job.

Estimating SD_y

To estimate SD_y, we made use of the SD_p ratio. This (SD_p) is the estimated performance at one standard deviation from the mean divided by the estimated performance at the mean. Judiesch, Schmidt, and Mount (1992) describe an objective method for estimating the value of average employee output. They conclude that the product of this value and the mean supervisory *ratings* of SD_p yields an unbiased estimate of SD_y.

A common criticism of utility work, however, is that estimates (especially of SD_y) tend to rely on judgmental rather than objective data. To avoid this criticism, we chose to use only objective data in our basic analyses. (A follow-up study may check the impact of using judgmental data through sensitivity analyses.) With objective estimates throughout this process, we avoided judgmental error in computing SD_y values for each enlisted job.

Hunter, et al. (1990) reviewed studies between 1937 and 1987. In their review, they selected studies that reported either SD_p or objective data from which they could calculate SD_p. Particularly important is that their review included only studies reporting on-the-job output or studies using work sample measures based on ratio

scales of output. They included only those studies which use a count of output to compute a score (either total or acceptable output). They specifically *excluded* studies having job sample measures based on *ratings* of quality or quantity of output.

Hunter et al. (1990) identified 59 jobs from studies meeting their criteria. First they calculated the observed incumbent SD_p values; then they corrected those for unreliability; and finally they corrected them for range restriction. With these procedures, they computed applicant SD_p values. If we ignore the sales jobs in their review, they report the following average SD_p values (as percentages of mean output) by job complexity: low complexity (40 jobs) -- 19.3%, medium complexity (12 jobs) -- 31.8%, and high complexity (7 jobs) -- 47.5%.

[In a later section where we recommend sensitivity analyses for a later study, we present results of SD_p *ratings* on one school in each of the complexity categories. Funding for this project prevented us from obtaining larger amounts of data and from conducting sensitivity analyses. Therefore, another reason to use the SD_p values provided by the literature is that they are based on more jobs (i.e., 59 jobs from the literature versus 3 or 4 jobs in this study).]

In addition to these measures of SD_p, we needed objective estimates of the mean value of employee output per job ($\bar{Y}$) to compute objective measures of SD_y (i.e., $SD_p * \bar{Y}$). Judiesch et al. (1992) provide an objective procedure for computing $\bar{Y}$. In developing their procedure, they begin by pointing out that the

mean value of employee output ($\bar{Y}$) is equal to total sales revenue divided by the total number of employees. They add that the revenue value of output will generally include contributions from more than one job within an organization. Under these conditions, they argue that an approximate estimate of the average revenue value for a particular job can be calculated under the assumption that the contribution of each job to the total revenue of an organization is proportional to its share of the organization's total annual payroll. They present the following formulas (their formula numbers in brackets) for a specific job (A):

$$\text{Job A Value} = \text{total revenue} * (\text{Job A payroll}/\text{total payroll}) \quad [31]$$

$$\bar{Y} = \text{Job A Value} / \text{Job A number of employees} \quad [32]$$

Judiesch et al. (1992) make several arguments and present a considerable amount of literature supporting their assumptions as reasonable. Several of our reviewers point out, however, that they do NOT expect pay for military jobs to accurately reflect the value of those jobs. First, our reviewers tend to believe that, overall, the pay in the military is less than that for comparable civilian jobs. They also believe that those in the more complex jobs are more underpaid than those in the less complex jobs. Indeed, a previous section of this report supports their point of view (see section entitled "Estimating Individual Marginal Utility in Dollars"). If we ignore these effects in our study, then we lose the increased economic benefit which really does exist for

classifying high ability personnel into the more complex jobs. In other words, ignoring these effects provides a conservative estimate (i.e., an underestimate) of utility. Therefore, we employed formulas [31] and [32] in our basic analyses without modifying them to compensate for possible underpayment in military jobs. A later study could conduct sensitivity analyses and incorporate procedures to offset these pay issues and assess the impact of these assumptions.

We computed $\bar{Y}$ from a military financial database following formulas [31] and [32]. We received a database (from Mr. Lou Pales of the Defense Manpower Data Center, DMDC, in Monterey) which includes financial data on over 2.4 million personnel in the military during fiscal year 1992. We also received documentation from the Pentagon Office of Public Affairs indicating that the total Department of Defense expenditures (i.e., the total revenue value in equation 31) for fiscal year 1992 amounted to $282.6 billion. Using the DMDC financial data base, we calculated the job payroll for each military job and the total military payroll (just over $50.8 billion). Entering these values into equation 31, we computed the job values for each military job. To calculate $\bar{Y}$, we divided job values by the number of work years worked for that military job during fiscal year 1992.

Table 13 shows the per person job values ($\bar{Y}$) for the 17 occupational specialties in our sample. That table also shows the job complexity categories, the SD_p values (one value per complexity category), and the SD_y values (job value * SD_p).

Insert Table 14 about here.

Developing Job Complexity Categories

As we developed estimates of marginal utility in dollars, the procedures above for estimating SD_y required that we obtain job complexity levels for our sample of 18 jobs as well as all entry-level MOSs. Several sections above refer to these job complexity categories or levels. This section describes how we developed those categories.

DMDC maintains data which delineates occupational specialties in terms of ratings on the data-people-things scale from the Dictionary of Occupational Titles (U.S. Department of Labor, 1977). Using a procedure defined by Hunter (1980), Abrahams et al. (1993) used these data to develop complexity ratings for the jobs in our sample. Complexity is defined as the level of cognitive information processing demands imposed by the job. Abrahams et al. determined that all the 18 jobs fall into one of four "complexity" levels. In a similar study, Schmidt et al. (1987) used a variant of this procedure but chose to combine two of the complexity categories. They worked with three complexity levels in their study of Navy jobs. Also, Hunter et al. (1990) used a similar procedure and worked with three levels in their analysis of studies in the literature. We worked with three complexity levels in this study so that we could readily use published SD_p values associated with each complexity level and more readily compare findings from

this study with findings of Schmidt, Hunter, and their colleagues. Because we worked with three rather than four levels of complexity, we expected our basic analyses to yield more conservative estimates of marginal utility.

Other Cost Considerations

As described above, the Ford-Fulkerson software employed the PP scores as input for each individual and optimized the assignment of individuals to jobs. In this section, we begin by describing several other cost considerations which we argue to ignore in this study. Essentially, ignoring cost differences between batteries due to the testing programs, attrition, recruiting, and processing efficiency leads to either no impact or a conservative solution. This subsection concludes by supporting our initial contention to use formula (4) to compute the total marginal utility per job ($\Delta U_{\text{Total Per Job}}$).

To compare the utilities of competing batteries, one might consider including values for such costs as: the testing program (c), attrition (a), recruiting (r), and processing efficiency (p). For a given job in our sample, then, we would adjust equation (4) to include these terms as follows:

$$\Delta U_{\text{Total Per Job}} = N_s \, \Delta\bar{U}_s - c - a - r + p \qquad (5)$$

For the moment, let's ignore the initial investment costs (e.g., investment in computers) required to implement a new battery. (In a later section, we discuss including this initial

investment.) At this point, let's examine the potential impact of ignoring each of these other cost considerations to determine whether this would provide more conservative estimates of utility for a new battery.

For example, an important benefit of a computerized adaptive battery is a reduction in Test Administrator time. This occurs because examinees complete those tests in less time. However, our comparisons between pairs of batteries held test time constant. This practically eliminated any differences in c between proposed batteries. In this case, we envisioned no bias in the utility estimate by ignoring this term.

Similarly, by ignoring the costs for attrition (a), recruiting (r), and processing efficiency (p), we expected either no bias or a more conservative utility estimate. Theoretically, the battery that achieves a higher average level of training or job performance will also produce less academic attrition during training and less attrition on the job. In turn, reduced attrition means reduced costs for recruiting. Regarding processing efficiency (p), our comparisons left no differences between batteries in proposed test time. This left little opportunity for differences in processing efficiency between batteries. It is possible, however, that the computerization of testing and scoring may offer opportunities to increase this value for new computerized tests. Hence, not including p in the equation might have provided a slight bias against new computerized tests. In summary, the net effect of

ignoring *c*, *a*, *r*, and *p* provided more conservative estimates of utility gains.

Our SOW requires that we develop a dollar metric that will allow improvements in validity or classification efficiency "to compensate for decrements in processing efficiency." Since the SOW does not require us to develop estimates for these other terms, we used equation (4) but not (5). Since the SOW does require us to show how to use the other terms with our components in future calculations of utility, we developed equation (5) to provide this information. However, note that if a new battery shows utility over the existing one without considering the cost savings for *c*, *a*, *r*, and *p*, then that utility estimate is probably a conservative one.

Generalizing From This Sample of Jobs

The SOW requires us to compare the utility of various pairs of batteries. Using equation (4) and ignoring the terms in equation (5) for *c*, *a*, *r*, and *p*, we calculated the total marginal utility of one battery ($\Delta U_{Total(a)}$) and the total marginal utility of a second ($\Delta U_{Total(b)}$) battery separately. Where the results of significance testing supported the difference between the benefits of the two batteries, we calculated marginal utilities and net present values. In determining the utility of one battery over another, we needed to generalize from our sample of 18 jobs to all 622 entry-level MOSs.

We generalized by assuming that all jobs within the same complexity level have the same SD_p value. First, we categorized

all jobs by complexity level to assign the appropriate SD_p value to each. Then, we multiplied each job's $\bar{Y}$ value by its SD_p value to obtain the SD_y value for the job. What remained was to estimate either r_{xy} and $\bar{Z}_{Xs}$ or the product of r_{xy} and $\bar{Z}_{Xs}$ (i.e., MPP) for all 622 entry-level MOSs for each battery. We made these estimates by using the MPP from each complexity level in our 18-school sample.

First, we describe how we estimated a weighted MPP_a ($WMPP_a$) for a new battery. We began by finding the mean of the MPP_a scores in each complexity category in our sample of 18 jobs. For example, if complexity category one (C1) has two jobs in our sample, then we computed a weighted mean MPP_a score for that category as:

$$MPP_{a(C1)} = \frac{(N_{(1)} * MPP_{a(1)}) + (N_{(2)} * MPP_{a(2)})}{(N_{(1)} + N_{(2)})}$$

where the subscripts $_{a(1)}$ and $_{a(2)}$ indicate values for a particular battery ($_a$) and for a particular school ($_{(1)}$ or $_{(2)}$). In this way, we computed an MPP for each of the three complexity categories for each battery.

We used the MPP for each complexity level from our 18-school sample to generalize to the 622 entry-level MOSs. Table 15 provides an overview of how we accomplished this generalization and computed ΔU_{Total} by battery. For each of the 622 entry-level MOSs, we applied equation (3) and computed $\Delta U_{Total\ (Per\ School)}$ for each battery as the product of MPP, SD_y, and N. Recall that N is the expected quota for each school for one fiscal year, MPP is the estimated mean performance for all jobs in a complexity level, and

SD_y is the SD_p value for the job's complexity level times the mean job value.

After computing this value for each job, we accumulated across all 622 entry-level MOSs for each battery and computed the total marginal utility. Table 15 shows these as $\Delta U_{Total(a)}$ and $\Delta U_{Total(b)}$ for batteries (a) and (b). Hence, the total net benefit (TNB) to the military for using one battery instead of the other is the difference between these two total marginal utilities:

$$TNB = \Delta U_{Total(a)} - \Delta U_{Total(b)} \tag{7}$$

Insert Table 15 about here.

Present Value Analysis

Developing the Procedures. In an analysis of the net present value (NPV), Cascio (1989) points out that NPV must be greater than zero to provide economic justification for investing in a personnel program. In equation (8) below, we substituted our Total Net Benefit (TNB) term where Cascio uses a Benefit (B) term:

$$NPV = -C + \sum_{t=1}^{n} TNB * \frac{1}{(1+i)^{t}} > 0 \tag{8}$$

where,

C is the initial setup cost of the second battery (for existing batteries, we assumed no initial setup cost),

TNB is the total *net* benefits (in incremental cash flow) of the new program over the existing,

i is the discount rate (currently 7%), and

n is the number of periods (years, t) over which the benefits of the new battery last.

Notice that the definition of *C* includes an assumption that existing batteries require no initial setup cost. Several comparisons outlined in the SOW call for modifying the first battery in some small way. Therefore, ignoring those setup costs biased the comparisons in favor of those first batteries and results in conservative estimates of marginal utility for a new battery.

For a discount rate (i), we used the 7% rate set forth as the government discount rate in OMB Circular A-94 (1992). As Zimmerman (1980) explains, an appropriate government discount rate must consider:

> ". . . the value of opportunities which the private sector must pass by when resources are withdrawn from that sector. A government project is desirable if, and only if, the value of the net benefits it promises exceeds the cost of the lost productive opportunities which that investment causes." (p. 9-1)

In other words, the government policy on discount rates encourages the use of discounting beyond simply offsetting the effects of inflation.

A final issue to consider regarding the variables in equation (8) is the value of n, the number of periods over which the benefits of the new battery will last. Since the ASVAB was initially implemented on January 1, 1976 (ASVAB Working Group, 1980), the ASVAB itself has enjoyed nearly 18 years of use in various forms. During the 17.75 years between January 1976 and October 1993, DoD had developed and retired 4 major versions of ASVAB Forms: 5, 6, & 7; 8, 9, & 10; 11, 12, & 13; and 15, 16, & 17. (They scheduled Forms 20, 21, & 22 for implementation in October 1993.) Four versions over 17.75 years yields an average life of about 4.44 years per version. For the purposes of this study, we initially set $n = 4$ when computing NPV using equation (8).

This decision to take the benefit of a new battery across only 4 years represents another conservative decision. It is conservative because we used 4 instead of 4.44 years. Secondly, it is conservative because we considered changes to an ASVAB <u>form</u> as a test change. (The last major change to ASVAB happened when DoD implemented ASVAB Forms 8, 9, and 10 in 1980.) Either way, the decision to use a new battery for only 4 years (or for only 4 annual cohorts) cuts short the period over which we accumulate the TNB term.

Finally, we considered the typical tenure of those enlisting. Using loss data provided by DMDC for fiscal years 1987 through 1989, we computed the average median tenure of enlisted personnel as 46.28 months. This indicates that, on average during those

fiscal years, half of those enlisting left the military before and half left after 46 months and 1 week of service.

Implementing the Procedures. In summary, we used 46.28 months as the median tenure of enlisted personnel. Also, we used 4 years as the typical life cycle of a DoD selection battery. Table 16 presents the procedures for accumulating TNB and determining its present value in FY92 dollars.

Insert Table 16 about here.

The first column shows the fiscal years over which a project would implement a new battery and then accumulate the benefits. NPRDC anticipates the initial setup to occur through 1997 and the first cohort to begin during 1997.

The second column shows that we placed all setup costs in the first year only. This clearly indicates the total projected investment costs. Not applying discounting procedures to the initial setup costs provides another conservative assumption. It assumes that all setup costs occur at the beginning of the first year. This makes the computerized or comparison battery appear to have relatively higher initial setup costs. (They appear higher in our analyses because we did not discount them.)

The third column uses the information that each cohort has a median tenure of 3.86 years. For each cohort year, this column provides the product of this median tenure and the TNB term.

The fourth column shows the appropriate discount factor for each cohort year. Since services recruit each cohort throughout any given year, the middle of a year is the typical starting point for any given cohort. For the first cohort (FY97 or the third project year), the typical ending point (i.e., the point that half the enlistees leave the military) is nearly four years later or the middle of the seventh project year. Therefore, this column shows the mid-year discount factor for the seventh year for the first cohort. Similarly, the typical ending points for cohorts two, three, and four are the middle of project years eight, nine, and ten. Therefore, the third column presents mid-year discount factors for years seven through ten. The final column shows how we accumulated the initial setup costs and the discounted TNB terms to compute a net present value of one selection battery over another.

Developing Initial Setup Costs by Battery. Table 17 shows the various components of the setup costs for each battery. Notice that we included no setup costs for paper-and-pencil batteries (i.e., batteries B_1 and B_2 in testing conditions A_1, A_3, A_5, and A_6). Working closely with NPRDC managers, we reasoned that current program funding would probably cover whatever minor changes or other setup costs those batteries may require. Pencil-and-paper batteries may, however, require additional funding for setup costs. Under such conditions, these analyses would underestimate setup costs for paper-and-pencil batteries and <u>underestimate</u> the present value of a computerized battery. This bias favoring paper-and-pencil batteries provides another conservative assumption.

Insert Table 17 about here.

Vicino, Hetter, Rafacz, Segall, and Unpingco (1993) provided the data for the setup costs of computerized tests shown in Table 17. Most of the costs appearing in Table 17 are the costs for fiscal years 1995 through 1997 shown in Vicino et al. (page 8, the table showing the funding profile for Scenario C: Desktop/Portable Mix). We did not include the normal operating costs shown in that table for OPM Test Administrators and the United States Military Entrance Processing Command (USMEPCOM), since these costs would exist for any of the alternatives and are not setup costs.

Foot note number one to Table 17 identifies the few costs that vary directly with test completion time: equipment and freight, maintenance, and computer support/supplies. The first category has the largest costs. These include the costs for purchasing micro-computers and shipping them to the required sites. Vicino et al. (Appendix D, 1993) describe the model developed (which uses a completion time of two hours) to describe machine requirements. This model identifies the need to vary the number of machines directly with the test completion times so that the average applicant waiting time remains less than 10 minutes. Working with this information, we interpolated or extrapolated from data in Vicino et al. to develop the cost figures for our Table 17. To compute the figures in Table 17 for Testing Condition A_2, for example, we took the ratio of the test time in A_2 to the test time

in Vicino et al. (1.66/2.00) times the cost figures in their report. Similarly, we used the ratio of 2.25/2.00 for condition A_4 and the ratio of 3.00/2.00 for conditions A_7 and A_8.

Attachment (5) of Vicino et al. (1993) provided the cost of Response Pedestals shown in Testing Condition A_8. Their table for Scenario C -- Desktop/Portable Mix showed a cost of $2.1 million for response pedestals.

Sensitivity and Break-even Analyses

Earlier in this plan, we describe how we used statistical tests to assess whether one battery yields improved predicted performance over another. Once we established the relative standing of any two batteries on predicted performance, the utility analyses above use a common metric (dollars) to quantify the extent of improvement. However, existing utility models contain no parameters reflecting variability in the estimates of the various components of the utility models. Recognizing this, we originally planned (lack of time prevents us now) to use sensitivity analyses and break-even analyses to assess the impact of uncertainty in our utility analyses.

In sensitivity analyses, we would have varied each of the utility parameters from a low value to a high value while holding other parameter values constant. By plotting and examining the resulting utility estimates, we could have identified which of the parameters' variability has the greatest effect on the total utility estimate.

In break-even analysis, we could have calculated the lowest value of any individual utility parameter (or combination of parameters) that still yields a positive Total Net Benefit (TNB) term. Any parameter value exceeding this "break-even" value would provide positive marginal utility. If sensitivity analyses are undertaken in the future, investigators should plot and examine the resulting utility estimates.

As Boudreau (1988) points out, break-even analysis allows decision makers to determine the critical values for utility parameters that could change the decision and determine whether to pursue further refinements in measurement. Where sensitivity analyses identify parameter break-even points that are substantially below the values we obtained in this study, then such findings will support the insensitivity of our findings to the uncertainty of the parameter estimates. Where parameter break-even points are relatively close to the values we obtained, then such findings will be sensitive to the uncertainty of our parameter estimates. Under these latter conditions, we may want to consider refinements in the measurements to better evaluate the utility the military would actually experience.

Results and Discussion

Overall Comparison of Eight Candidate Batteries

Using the regression equations developed for each candidate battery, we conducted preliminary analyses of their expected effectiveness prior to generating optimal school assignment solutions. In these analyses, we compared the eight testing conditions on various indices that either contribute to or directly estimate their relative classification efficiency. Table 18 displays these indices for the eight testing conditions. The first two columns of Table 18 list the testing conditions (TC) and their corresponding battery. The third column, Time, indicates the number of minutes for each battery.

Insert Table 18 about here.

The next column of Table 18, Phi, provides Horst's index of differential prediction efficiency, ϕ, for each of the batteries. Although this index has no simple interpretation, the larger the value, the greater the differential prediction efficiency of the battery. As Table 18 indicates, this index becomes larger as the battery becomes longer, or more complex (i.e., includes more tests). Because the batteries B_2, B_4 and B_5 are computer administered, some examinees take more time and some examinees take less time, although the expected or average completion time must remain as the Time column indicates.

Column R′ presents the average multiple correlation for each battery. The following column, r′, is the average intercorrelation among the least squares prediction equations for the battery. Examination of these two columns offers some insight into Horst's process. Notice that, as the computerized testing conditions (A_2, A_4, A_7, and A_8) increase in length or complexity, the value R′ goes up while the value r′ goes down. This relationship also occurs for the paper-and-pencil testing conditions (A_1, A_3, A_5, and A_6). Because Horst's process adjusts the test lengths to maximize R′ while minimizing r′, we expect this relationship. There are no beta weights that will yield a higher R′ for these batteries at their final lengths. (At the completion of Horst's procedure, the beta weights for multiple absolute prediction are identical to those for multiple differential prediction).

The AA column represents the allocation average (mean criterion score), which we estimated using Brogden's (1959) procedure. This procedure assumes equal quotas for each school. We estimated these averages using R′, r′, the selection ratio, and the number of schools. The C column presents the multiplier for Brogden's allocation average measure. We define the value C as:

$$C = R'\sqrt{1-r'} \qquad (9)$$

Brogden's (1959) equation assumes that the validities (R′) are the same for all 18 regression equations, as are their intercorrelations (r′). Nevertheless, If we substitute the mean values, R′ and r′, in equation (1), it provides a good

approximation for Brogden's (1959) measure. Notice that, as expected, C increases as the battery increases in length and complexity. The larger this index C, the greater the differential effectiveness of the battery, regardless of the selection ratio. This index clearly shows that decreasing intercorrelations between composites provides real gains in Classification efficiency even if absolute validity remains constant.

As indicated earlier, the AA column provides Brogden's (1959) Allocation Average. These are the average expected criterion z-scores for selectees. To obtain these AA values, we first calculated Brogden's AA index assuming: 1) 18 schools, 2) a selection ratio of .6523913, 3) a composite validity of 1.00, and 4) a composite intercorrelation of .00. Then we multiplied this common AA by each testing condition's unique C value to obtain the Brogden's AA values in Table 18. As this table illustrates, this average, which is the average expected criterion z-score for selectees, increases as the battery increases in length and complexity. We would expect about 1/5 of a standard deviation increase in performance among selectees using the best battery, A_8, as compared to the worst battery, A_1.

It is worth noting that changes in intercorrelations among the prediction equations appear to have a greater impact on the allocation average than changes in the absolute validity of the equations. That is, from treatment A_1 to treatment A_8, the average multiple R (i.e., R' in Table 18) goes from .6908 to .7449. This is a change of .0541, or a gain of just under 8%. However, the

allocation average goes from .3912 to .6285, which is a change of .2337, or a gain of just under 60%. This would suggest that concentrating on absolute (or incremental) validity alone in assessing or selecting a battery of tests may fail to realize the gains in classification efficiency that might be possible.

Column G presents the expected allocation average if we assigned all individuals using a single factor, such as G, and if the average R for this factor were the value given in the R′ column. Table 18 shows that differential effectiveness only slightly increases the allocation average of the worst battery, A_1. However, battery A_8 shows a considerable gain in differential effectiveness.

Recall that, for each of the eight testing conditions, we conducted eight replications, resulting in 64 unique assignment solutions. For each of these 64 solutions, we computed a mean predicted performance value (see Appendix H). Table 19 presents the analysis of variance of these 64 MPPs. We analyzed these data using a mixed model, with blocks random and treatments fixed. For this model, the appropriate error term for testing the significance of differences between testing conditions is the mean square (MS) for treatments X blocks (Edwards, 1972, p. 240).

Insert Table 19 about here.

As Table 19 indicates, the testing condition factor is statistically significant, $\underline{F}(7, 49) = 50.46$. We may use eta

squared to estimate the proportion of total variance accounted for by the testing condition factor (McNemar, 1962, p. 279). This statistic is descriptive rather than inferential in this instance. Eta squared, computed by SSA/SST, equals .4978. Thus, the testing condition factor accounts for approximately half of the total variance in predicted performance values. The mean predicted performance values for the eight batteries range from .60 to .74, reflecting a 23% increase in expected performance.

Specific Contrasts of Candidate Batteries

Because the overall $\underline{F}$-test revealed significant differences between testing conditions, we conducted further significance tests. These tests involve the pairs of batteries hypothesized to differ in classification efficiency. Table 20 shows the significance test results for the six planned comparisons. These comparisons test the directional hypotheses we made before examining any results. Consequently, the values in Table 20 do not require corrections in alpha level for capitalization on chance. We used one-tail $\underline{t}$ tests to assess significance (see McNemar, 1962, p. 285).

Insert Table 20 about here.

The first comparison (SOW 4.4.1) of candidate test batteries contrasts the classification efficiency of a P&P-ASVAB to that of a CAT-ASVAB. One hundred minutes of testing time, optimally allocated to the individual tests, are available for each battery.

We hypothesized that the computerized battery would out-perform the P&P battery because its greater reliability will result in greater validity. As Table 21 indicates, the CAT-ASVAB provided greater classification efficiency than the P&P-ASVAB. The resulting allocation averages of .65 for CAT-ASVAB and .60 for P&P-ASVAB are statistically significant, $\underline{t}(49) = 4.96$, $\underline{p} < .001$. We may attribute this gain in classification efficiency to the computerized mode of administration.

Insert Table 21 about here.

The second question (SOW 4.4.2) examines the difference between an expanded P&P-ASVAB battery and an expanded CAT-ASVAB battery. Specifically, we compared a P&P battery, containing ASVAB plus three P&P-format ECAT tests, to a computerized battery, containing CAT-ASVAB and six non-pedestal ECAT tests. In this comparison, we optimally allocated 135 minutes to the tests in each battery. The computerized battery contains all the tests of the P&P battery plus three additional tests, which could only increase the utility of the computerized battery. Therefore, we hypothesized that the expanded P&P-ASVAB would have lower utility than the expanded CAT-ASVAB. As expected, the expanded computerized battery out-performed the expanded P&P battery, $\underline{t}(49) = 7.11$, $\underline{p} < .001$. As Table 21 shows, the allocation average of the P&P battery is .62 and that of the computerized battery is .69. This gain may be due to both mode of administration and the

additional three tests, two of which measure non-verbal reasoning and one measuring spatial ability.

The third comparison (SOW 4.4.3) contrasts the classification efficiency of a P&P-ASVAB and that of an expanded P&P-ASVAB. Specifically, the expanded ASVAB includes three ECAT tests in P&P format. For both batteries, 180 minutes are optimally allocated to the individual tests. For this contrast, we hypothesized that the expanded ASVAB (i.e., ASVAB plus three ECAT tests) would provide greater classification efficiency than would the ASVAB alone. The addition of individual tests, with test time set to maximize their contribution, can only increase efficiency. As Table 21 reveals, the expanded ASVAB yielded a higher classification efficiency than the ASVAB alone. The resulting allocation averages are .62 and .64 for ASVAB and the expanded ASVAB, respectively. Although the difference (.02) between these averages is the smallest observed among the six planned comparisons, it is statistically significant, $\underline{t}(49) = 1.92$, $\underline{p} < .05$. This increase in classification efficiency results from the additional three tests, which primarily measure spatial ability.

The fourth contrast (SOW 4.4.4) of test batteries compares a P&P battery, containing a P&P-ASVAB plus three ECAT P&P-format tests, to a computerized battery, containing a CAT-ASVAB and six non-pedestal ECAT tests. This comparison involves batteries which are also in our second hypothesis (4.4.2). However, for this fourth comparison, we optimally allocated <u>180</u> minutes to the individual tests. Because the computerized battery includes all

the tests of the P&P battery plus three additional tests, as with our second hypothesis, we expected the computerized battery to provide greater classification efficiency. As Table 21 shows, the computerized battery out-performed the P&P battery. The allocation averages of .71 and .64 for the two batteries (respectively) are significantly different, $\underline{t}(49) = 7.29$, $\underline{p} < .001$. Like the results from our second hypothesis, this gain may be due to both mode of administration and the additional three tests, two of which measure non-verbal reasoning and one measuring spatial ability.

The fifth comparison (SOW 4.4.5) contrasts two computerized batteries: a CAT-ASVAB plus the six non-pedestal ECAT tests, and a CAT-ASVAB plus a full ECAT. We optimally distributed 180 minutes to the individual tests in each battery. Because it has three additional tests, we hypothesized that the battery containing the CAT-ASVAB plus a full ECAT would have the higher classification efficiency. As expected, battery containing CAT-ASVAB plus the full ECAT revealed significantly higher classification efficiency when compared to the CAT-ASVAB plus non-pedestal ECAT battery, $\underline{t}(49) = 3.20$, $\underline{p} < .01$. Table 21 displays allocation averages of .74 and .71 for these batteries, respectively. This gain in classification efficiency may be the result of the unique variance measured by the three pedestal tests, two of which involve psychomotor skills and one measuring perceptual speed.

Finally, the sixth question (4.4.6) examines the difference between the utility of a P&P battery, containing a P&P-ASVAB plus three P&P-format ECAT tests, and a computerized battery, containing

a CAT-ASVAB plus all ECAT tests. For both batteries, we optimally distributed 180 minutes to the individual tests. Here, the computerized battery contains all the tests of the P&P battery, plus six additional tests. Consequently, we hypothesized that the P&P battery would have lower utility than the computerized battery. As Table 21 shows, the computerized battery out-performed the P&P battery. The allocation averages of .64 and .74 for the P&P and the computerized battery (respectively) are significantly different, $\underline{t}(49) = 10.49$, $\underline{p} < .001$. This gain in classification efficiency is due to the computerized administration mode, and the additional six tests. Of these six tests, two measure non-verbal reasoning, one involves spatial ability, two assess psychomotor skills, and one measures perceptual speed.

The results of these contrasts, and an inspection of mean predicted performance values in Table 21, indicate that changes in battery length, composition, and mode of administration lead to statistically and practically significant increases in classification efficiency. These increases translate into practical gains in expected performance. Such gains result from the combined effects of increases in validity and decreases in intercorrelation of the predicted criterion scores of each testing condition.

The maximum possible gain in MPP between any two of these candidate test batteries is the .14 difference observed between a 100-minute P&P ASVAB battery and a 180-minute CAT-ASVAB plus full ECAT battery. These two batteries differ in terms of time,

composition, and mode of administration. Because these three factors (time, composition, mode of administration) are confounded, it is not possible to precisely determine each factor's contribution to the .14 increase in mean predicted performance. However, inspection of the means in Table 21 suggests that the time increase results in .02 MPP points, computer administration results in .05 points, and battery composition results in .07 points.

Results of Utility Analyses

MPP Values by Testing Condition and Hypothesis

Table 22 presents mean predicted performance (MPP) values by testing condition and hypothesis. The Method section on Generalizing From This Sample of Jobs describes how we obtained the MPPs displayed in Table 22. For every battery, we weighted each of the three MPP values obtained from our sample of 18 jobs by the number of people in the corresponding complexity level for the 622 MOSs. The MPP values shown in Table 22 differ from previous values in that they include more appropriate weights for all three complexity levels.

The 622 entry-level MOSs provide greater opportunity for increases in classification efficiency than possible with 18 jobs. To adjust for the increased classification efficiency expected with increased assignment possibilities, we multiplied the Brogden factors (presented in Table 23) by the mean predicted performance values in Table 22. The parenthetical values in Table 22 display the Brogden adjusted values. (To estimate classification

efficiency and utility for 100 jobs, multiply the non-parenthetical values in Table 22 by 1.29.)

Insert Table 22 about here.

Table 22 also displays specific comparisons between batteries in accordance with the SOW. Each row of Table 22 represents a specific study hypothesis. The first entry in each row represents the mean MPP for the first battery, while the second entry in each row represents the second battery. The last entry in each row is the "Delta_{MPP}". The "Delta_{MPP}" column represents the difference in utility between the two batteries for each comparison. The positive values in this column indicate that all differences in MPP values were in the predicted direction. Since the t-test performed on the planned comparisons indicate that all differences were significant, we applied the utility analysis procedures to all the comparisons identified by the hypotheses.

Insert Table 23 about here.

Total Utilities by Testing Condition and Hypothesis

Table 24 presents the total utilities (i.e., across all selectees and all schools) by testing condition and research question. Tabled values are in millions of fiscal year 1992 dollars. Except for the last column, each column in Table 24 presents a ΔU_{Total} value from equation (7). For all rows, $\Delta U_{Total(b)}$

is the first entry in the row and $\Delta U_{Total(a)}$ is the second. As equation (7) provides, the Total Net Benefit (TNB) term (the final entry in the row) is $\Delta U_{Total(a)}$ minus $\Delta U_{Total(b)}$.

Insert Table 24 about here.

As with Table 22, the parenthetical values in Table 24 display the Brogden adjusted values. Only these values in parentheses reflect the total utilities that consider the classification efficiency achieved by having 622 (instead of 18) jobs in which to classify selectees.

Present Value Analyses by Hypothesis

Tables 25 and 26 display the results of present value analyses. Table 25 presents analyses based on the MPP values provided by our sample; and Table 26 presents analyses based on MPP values adjusted by the Brogden factors. As before, only the Brogden-adjusted utilities reflect the total utility considering the 622 entry-level jobs in the military as compared with the 18 jobs in our sample.

Insert Table 25 about here.

Near the top of Tables 25 and 26, the first row containing values presents the utility of "3.86 years of TNB per cohort". This is the <u>un</u>discounted value of the TNB term from Table 24 times the median tenure of enlistees (about 3.86 years). Typically, half

the enlistees leave the military before and half leave after serving 3.86 years. Presumably, many of those staying in the military beyond 3.86 years will have gained more experience, earned greater rank, and provided greater productivity. Because all of this occurs later in time, however, their utilities should be discounted more. Similarly, those leaving prior to 3.86 years will have gained less experience, earned less rank, and provided less productivity. Because this occurs sooner in time, their utilities should be discounted less. By using the median or "typical" value, we designed these analyses to estimate the TNB for the entire cohort.

Insert Table 26 about here.

The rest of the table entries show the values for various features of the present value analyses for each hypothesized comparison. The entries for fiscal year 1995 show the initial setup costs. As mentioned in the Method section of this report, we did not discount these values. This has the effect of treating these initial investment costs as occurring all at the beginning of 1995. Because DoD would likely spread these costs over several years, this procedure over-estimates these investment costs and under-estimates the utility of the batteries hypothesized as more effective.

Costs presented in the tables for fiscal years 1997 through 2000 show the discounted (or present) values of the 3.86 years of

TNB per cohort. These figures are the product of the discount factors from Table 23 times the 3.86 years of TNB per cohort shown in these tables. The final row sums across fiscal years 1995 to 2000 to obtain the net present values by hypothesized comparisons. These show the present values (net of investment costs) of the total utility of the hypothesized battery for each comparison.

As stated above, results of statistical analyses showed that the hypothesized batteries provided significantly higher MPPs for each of the six comparisons. Since our dollar utilities are a linear conversion of those results, Tables 25 and 26 show utility gains proportionate to the observed differences in MPP scores for each comparison. When we inspect Table 26, we see that the three comparisons showing the greatest utility gains are those comparing CAT ASVAB plus some form of ECAT against any P&P test. The utilities range between 9.6 and 11.6 billion dollars for a CAT-ASVAB plus some form of ECAT. The lowest utilities compare two P&P or two computerized tests. The utilities of these comparisons are: (a) 3.2 billion dollars for a CAT-ASVAB and full ECAT over a CAT-ASVAB plus a non-pedestal ECAT, and (b) 2.3 billion dollars for a P&P-ASVAB plus P&P-ECAT over P&P-ASVAB alone.

A Framework for Understanding Utility Gains

Utility gains from implementing new selection procedures in a large organization often appear incredible to managers responsible for using those gains. By comparing the identified utility gains with other available standards, DoD managers will develop a better

perspective regarding the relative value of those gains and how best to realize them.

This study's largest utility gain occurred with the comparison between the two 180-minute batteries of comparison six: the P&P-ASVAB plus P&P-ECAT (battery A6) and the CAT-ASVAB plus full ECAT (battery A8). The subsections below help place in perspective the nearly $11.6 billion utility gain estimated by that comparison. The same rationale described in those subsections applies to the utility gain provided by any of the other six planned comparisons of this study.

Utility Gains as a Percent of the DoD Budget. One standard for interpreting the value of utility gains is to compare the estimated $11.6 billion against the annual DoD Budget. For fiscal year 1992, DoD's annual expenditures amounted to $282.6 billion. From this perspective, the entire $11.6 billion gain due to improved selection and classification provided by comparison six equals only about 4.1% (11.6/282.6) of one year's total DoD budget.

Utility Gains Per Year as a Percent of the DoD Budget. Continuing with this example, DoD would realize its gain over several cohorts and several years. Considering that the fourth cohort begins three years after the first and assuming that 20 years is the longest career of any single individual, then it takes about 23 years to accumulate all the utility gains. Yes, the $11.6 billion gain occurs over 23 years and equals 4.1% of the annual DoD budget. The typical gain in any given year, though, is less than

two tenths of one percent (i.e., the fraction .00178 or 0.178%) of the DoD annual budget.

Utility Gains as a Uniform Annual Cash Flow. Another method for interpreting the value of utility gains is to consider the average annual increment in cash flow provided by the improved procedures. Considering the $11.6 billion over 23 years, the present value of the average annual increment in cash flow amounts to $504 million.

Comparing These Utility Gains with Those of a Previous Study. Cascio and Ramos (1986) report on the utility gains of an improved selection procedure for first-level managers in a division of a Bell operating company. They identified a utility gain of $2,676 per selectee per year. If we divide the $504 million per year by the roughly 233,000 military selectees per year, our study shows an average annual utility gain of about $2,163 per military selectee.

Utility Gains Expressed in Salary Terms Only. The Office of Personnel Management (OPM) has invested considerable time and effort in understanding compensation strategies available to the Federal Government. In the process, Schay (1993) observes that most managers in the Federal Government are not fully aware of the cost of doing business. She suggests that managers in the Federal Government recognize salaries as a cost of doing business, but they do not recognize the other direct and indirect business costs.

Schay's (1993) observations suggest that DoD managers may have difficulty in understanding or believing the military job values we computed (see Table 11). For these managers, we suggest presenting

utility gains adjusted to reflect salaries alone. Since total DoD salaries in fiscal year 1992 equaled about $50.8 billion, salaries equal about 18% (50.8/282.8) of the total budget; and the $11.6 billion in utility gains amounts to $2.1 billion in salaries alone.

Realizing Utility Gains. The improved selection and classification of personnel into the military can provide the identified utility gains only if DoD managers take action to realize them. When a new selection and classification system begins supplying higher quality entry-level military personnel, these personnel will learn their jobs more quickly and perform them more efficiently. If they fill jobs designed for personnel of lesser ability, they may complete the work for those jobs in less time and have little to do thereafter. Under these conditions, however, they may provide no real utility gains. In order for DoD to realize the utility gains, they must have an opportunity to perform either more of the same level of work or work of greater complexity suited to their greater ability. DoD may need to redesign jobs in order to realize the potential utility gains.

For illustration purposes, think about realizing the potential utility gains from improved selection and classification systems through reduced hiring. (This approach may have some appeal under the current climate of downsizing. This illustration, however, will set the stage for another means for realizing utility gains.) For example, dividing the annual DoD expenditures (about $282.6 billion) by the number of uniformed military personnel (about 2.4 million) provides a typical job value of about $118,000. One way

to ensure realizing a projected \$504 million annually is to reduce the number of military jobs. In other words, the permanent elimination of 4,271 military jobs (\$504 million divided by \$118,000 per job) would ensure capturing the average annual increment in cash flow projected from using the new system.

Such an approach amounts to eliminating the jobs associated with the 0.178% per year utility gain. At this time, however, the military has already incurred a substantial amount of downsizing and is already engaging in a considerable amount of re-designing jobs and re-structuring work flow. Under these circumstances, an improved selection and classification system can provide improved personnel resources for those expanded or enriched jobs. This will enable the down-sized military forces to retain more of their original effectiveness without increasing expenditures.

Conclusions

The results of the present study support the following conclusions:

1. Use of a computerized mode of administration and/or computer-adaptive tests increases classification efficiency and the concomitant classification utility over that of a paper-and-pencil mode of administration. The increase in classification efficiency translates into practical gains with respect to expected performance.
2. Inclusion of additional tests increase classification efficiency and, in turn, increase classification utility, over that of the basic ASVAB or CAT-ASVAB.
3. Although we did not specifically test the significance of manipulating test time among the candidate batteries, test time appears to increase classification efficiency and utility. However, this increase is small, relative to increases due to test computerization and expansion.
4. We did not compare an ASVAB (or CAT-ASVAB) alone to an ASVAB (or CAT-ASVAB) plus full ECAT battery, holding test time constant. Based on the comparisons we do make, it appears that the addition of ECAT to an ASVAB (or CAT-ASVAB) battery provides a substantial gain in classification efficiency. Since the ECAT demonstrated little improvement in absolute validity, the gain in classification efficiency resulted primarily from decreases in composite intercorrelations.

5. Under the assignment conditions used in this study, using the CAT-ASVAB plus full ECAT instead of using P&P-ASVAB and three ECAT tests provided the largest gain in utility. In this comparison, we estimated the dollar value of the utility gain at about $11.6 billion or about 4.1% of the DoD expenditures for fiscal year 1992 (FY 92). Since DoD would accumulate these gains over several years, the present value of the average increment in cash flow would amount to about $504 million annually. This amounts to 0.178% of DoD expenditures for FY 92.

Recommendations

We recommend the development of procedures to construct test batteries and regression equations that will simultaneously maximize classification efficiency while minimizing adverse impact. The optimization procedures developed in this study emphasize classification efficiency alone. It may be possible to develop a combined objective function that will result in test batteries and regression composites that maximize differential validity and minimize adverse impact.

We also recommend the evaluation of the incremental classification efficiency of the existing ECAT battery over the existing ASVAB (or CAT-ASVAB). Such an evaluation could lead to improvements in personnel classification without spending additional time or funding on test development.

In order to more completely reflect the utility of increased classification efficiency achieved from improved predictor batteries, we recommend the development of procedures to include the non-dollar job values that the military places on job performance. At the beginning of this study, we developed and applied procedures to assign a dollar-based job value to military jobs. During the course of applying those procedures, we discovered that military pay practices do not completely reflect the value the military places on its jobs. By using those dollar-based job values in this study, we computed dollar-based utilities that probably <u>under</u>estimate the value of job performance to the military.

During the course of developing and applying procedures for conducting utility analyses, we made literally dozens of decisions that affected the results. In every case, we chose the working assumption that minimized the incremental utility of the battery hypothesized as more effective. While such assumptions do produce more conservative results, some may argue that the many conservative assumptions produce results that simply are too conservative. Therefore, we recommend that the Government conduct sensitivity analyses to investigate the cumulative impact of these conservative assumptions.

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Appendix A
ASVAB and ECAT Intercorrelations and Validities: Corrected and Uncorrected

Table A-1

Population #1 Matrix
ASVAB Intercorrelations, Means and Standard Deviations
from the 1991 DOD Population of Applicants

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	MEAN:	SD:
GS:	0.611	0.720	0.608	0.275	0.249	0.520	0.554	0.638	0.625	50.615	8.773
AR:		0.596	0.574	0.470	0.395	0.400	0.707	0.613	0.487	50.664	8.645
WK:			0.732	0.324	0.328	0.437	0.497	0.547	0.534	51.311	7.354
PC:				0.396	0.386	0.339	0.500	0.485	0.444	51.156	7.964
NO:					0.640	0.047	0.496	0.228	0.145	52.512	8.013
CS:						0.058	0.408	0.221	0.147	52.266	7.812
AS:							0.197	0.618	0.669	51.409	9.168
MK:								0.494	0.370	51.210	8.689
MC:									0.630	51.941	9.127
EI:										50.333	8.856

Table A-2

DATA FILE: JS01.DAT .
AC SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 72 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.442	0.461	0.311	-0.002	-0.095	0.526	0.247	0.534	0.524
2		0.315	0.176	0.047	0.033	0.290	0.402	0.422	0.381
3			0.442	-0.196	-0.096	0.271	0.308	0.343	0.410
4				0.156	0.105	0.402	0.315	0.268	0.248
5					0.400	0.169	-0.020	-0.033	0.022
6						0.144	-0.060	0.105	-0.065
7							0.142	0.642	0.637
8								0.081	0.179
9									0.541
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.247	0.249	0.331	0.163	0.306	0.329	-0.079	-0.174	-0.254	0.372	55.556	6.375
2	0.312	0.286	0.411	0.253	0.513	0.398	-0.152	-0.097	-0.172	0.420	56.569	5.574
3	0.138	0.197	0.242	0.189	0.237	0.074	-0.155	-0.087	-0.178	0.205	54.361	4.098
4	0.170	0.291	0.206	0.243	0.272	0.212	-0.108	-0.157	-0.262	0.337	54.292	5.327
5	0.066	0.105	0.203	0.179	0.061	0.348	-0.019	-0.216	-0.264	0.116	55.486	5.998
6	0.177	0.106	0.196	0.107	0.052	0.232	-0.251	-0.200	-0.336	0.192	54.653	6.420
7	0.141	0.458	0.557	0.262	0.388	0.491	-0.260	-0.471	-0.566	0.332	51.431	8.388
8	0.079	0.125	0.250	0.168	0.103	0.175	-0.229	-0.173	-0.193	0.435	60.250	4.131
9	0.276	0.441	0.521	0.427	0.375	0.426	-0.263	-0.286	-0.485	0.239	56.083	7.868
10	0.132	0.288	0.383	0.136	0.237	0.257	-0.135	-0.211	-0.309	0.344	51.278	8.021
11		0.381	0.165	0.362	0.302	0.408	-0.173	-0.027	-0.094	0.262	0.699	0.107
12			0.413	0.479	0.384	0.385	-0.224	-0.250	-0.371	0.306	0.731	0.150
13				0.556	0.399	0.406	-0.366	-0.396	-0.521	0.242	0.795	0.116
14					0.498	0.448	-0.396	-0.255	-0.378	0.228	0.679	0.177
15						0.383	-0.122	-0.196	-0.322	0.249	0.605	0.232
16							-0.430	-0.369	-0.450	0.336	0.770	0.133
17								0.471	0.427	-0.163	1.802	0.552
18									0.825	-0.110	2696.350	336.942
19										-0.203	3549.570	468.301
20											84.525	4.749

Table A-3

DATA FILE: JS02.DAT
AE SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 173 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.295	0.571	0.390	0.137	0.045	0.477	0.194	0.433	0.485
2		0.386	0.350	0.205	0.139	0.332	0.405	0.321	0.301
3			0.520	0.150	0.089	0.411	0.291	0.304	0.430
4				0.179	0.162	0.263	0.270	0.259	0.340
5					0.488	0.003	0.221	-0.131	-0.041
6						0.046	0.163	-0.041	-0.109
7							0.240	0.502	0.590
8								0.205	0.264
9									0.483
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.254	0.303	0.300	0.230	0.246	0.144	-0.276	-0.276	-0.283	0.363	53.561	6.306
2	0.346	0.373	0.412	0.320	0.273	0.402	-0.087	-0.151	-0.096	0.331	52.399	6.547
3	0.133	0.206	0.238	0.020	0.218	0.155	-0.043	-0.183	-0.138	0.332	52.376	5.033
4	0.189	0.177	0.177	0.043	0.184	0.175	-0.084	-0.179	-0.116	0.240	52.295	6.781
5	0.154	0.102	-0.024	-0.164	0.005	0.215	-0.048	-0.078	-0.019	0.093	54.249	6.004
6	0.229	0.129	0.074	0.020	-0.002	0.359	-0.014	-0.118	-0.179	0.159	51.884	6.328
7	0.084	0.318	0.293	0.256	0.186	0.122	-0.187	-0.211	-0.151	0.386	52.387	7.809
8	0.152	0.250	0.242	0.125	0.252	0.252	0.002	-0.083	-0.021	0.319	56.052	5.317
9	0.199	0.319	0.340	0.385	0.371	0.199	-0.197	-0.307	-0.356	0.294	53.960	7.178
10	0.148	0.371	0.373	0.309	0.316	0.128	-0.134	-0.187	-0.156	0.406	52.087	8.082
11		0.495	0.369	0.389	0.345	0.637	-0.265	-0.401	-0.401	0.317	0.651	0.142
12			0.493	0.519	0.362	0.519	-0.220	-0.369	-0.315	0.362	0.680	0.162
13				0.450	0.448	0.452	-0.170	-0.310	-0.345	0.393	0.748	0.118
14					0.463	0.419	-0.268	-0.339	-0.326	0.320	0.628	0.180
15						0.310	-0.137	-0.421	-0.374	0.309	0.478	0.248
16							-0.251	-0.400	-0.363	0.370	0.709	0.168
17								0.333	0.374	-0.236	1.854	0.637
18									0.663	-0.306	2784.304	389.968
19										-0.206	3675.108	485.639
20											83.443	5.946

Table A-4

DATA FILE: JS03.DAT
AMS SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 244 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.232	0.498	0.267	0.042	0.033	0.144	0.328	0.201	0.328
2		0.310	0.217	0.327	0.169	-0.124	0.514	0.154	0.001
3			0.480	0.134	0.142	0.150	0.289	0.211	0.311
4				0.183	0.142	-0.010	0.186	0.145	0.128
5					0.499	-0.093	0.432	0.058	0.045
6						-0.147	0.201	0.101	-0.039
7							-0.120	0.028	0.381
8								0.163	0.066
9									0.221
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.002	0.191	0.091	0.112	0.132	-0.047	-0.081	-0.029	-0.011	0.384	54.471	6.285
2	0.327	0.255	0.329	0.251	0.169	0.300	-0.006	-0.050	-0.085	0.300	56.004	5.699
3	0.032	0.156	0.115	0.139	0.158	-0.024	-0.006	0.012	-0.014	0.424	53.471	4.612
4	0.052	0.096	0.050	0.036	0.034	0.032	-0.007	-0.035	-0.013	0.231	53.361	6.877
5	0.219	0.135	0.213	0.192	0.022	0.322	-0.023	-0.217	-0.139	0.247	53.201	6.122
6	0.167	0.107	0.129	0.217	0.010	0.182	-0.085	-0.110	-0.148	0.270	52.295	6.663
7	-0.159	-0.098	-0.078	-0.054	-0.083	-0.223	0.011	0.094	0.192	0.144	60.139	5.255
8	0.240	0.299	0.326	0.317	0.242	0.311	-0.029	-0.205	-0.172	0.373	54.053	6.952
9	0.097	0.235	0.259	0.231	0.301	0.150	-0.035	-0.123	-0.161	0.231	60.324	5.179
10	-0.149	0.055	-0.016	0.041	0.056	-0.167	-0.004	0.016	0.028	0.255	55.197	6.402
11		0.350	0.320	0.265	0.173	0.520	-0.068	-0.188	-0.300	0.091	0.684	0.115
12			0.428	0.338	0.265	0.353	-0.195	-0.243	-0.260	0.171	0.716	0.154
13				0.463	0.386	0.413	-0.097	-0.168	-0.250	0.199	0.806	0.098
14					0.366	0.389	-0.277	-0.252	-0.251	0.201	0.680	0.186
15						0.216	-0.105	-0.209	-0.214	0.117	0.609	0.237
16							-0.107	-0.276	-0.307	0.065	0.755	0.158
17								0.352	0.276	-0.037	1.776	0.507
18									0.692	-0.051	2728.066	325.099
19										-0.047	3566.997	445.392
20											83.515	4.225

Table A-5

DATA FILE: JS04.DAT
AO. SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 233 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.204	0.498	0.361	-0.021	0.021	0.257	0.228	0.386	0.279
2		0.317	0.272	0.307	0.266	0.158	0.515	0.350	0.116
3			0.507	-0.074	0.040	0.269	0.177	0.347	0.302
4				0.066	0.116	0.161	0.148	0.222	0.293
5					0.689	-0.109	0.341	-0.034	-0.102
6						-0.006	0.266	0.074	0.033
7							-0.042	0.426	0.512
8								0.221	-0.027
9									0.339
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.085	0.169	0.173	0.121	0.213	0.007	-0.230	0.005	0.014	0.222	53.107	6.064
2	0.281	0.345	0.254	0.282	0.338	0.359	0.018	-0.041	-0.037	0.313	51.378	6.508
3	0.007	0.125	0.102	0.100	0.133	-0.037	-0.019	-0.024	0.050	0.199	51.974	5.027
4	0.137	0.114	0.157	0.095	0.180	0.068	-0.032	0.031	-0.033	0.200	51.755	5.796
5	0.139	0.060	0.039	0.028	0.091	0.296	-0.078	-0.121	-0.107	0.230	52.412	7.036
6	0.188	0.030	0.110	0.112	0.138	0.308	-0.093	-0.146	-0.141	0.263	50.914	6.858
7	-0.018	0.140	0.300	0.313	0.164	0.089	-0.101	-0.068	-0.018	0.179	53.335	7.473
8	0.198	0.266	0.245	0.220	0.253	0.263	-0.034	-0.018	0.016	0.390	52.489	6.788
9	0.144	0.377	0.409	0.451	0.386	0.230	-0.128	-0.171	-0.166	0.189	53.841	7.024
10	-0.022	0.192	0.226	0.223	0.113	-0.046	-0.065	0.086	0.065	0.182	52.996	6.274
11		0.335	0.313	0.303	0.297	0.519	-0.205	-0.190	-0.246	0.060	0.653	0.135
12			0.451	0.432	0.327	0.345	-0.045	-0.045	-0.112	0.167	0.655	0.170
13				0.558	0.442	0.345	-0.180	-0.197	-0.220	0.220	0.739	0.133
14					0.509	0.419	-0.186	-0.186	-0.297	0.237	0.603	0.185
15						0.360	-0.132	-0.188	-0.245	0.209	0.487	0.236
16							-0.237	-0.254	-0.318	0.166	0.693	0.185
17								0.125	0.209	-0.146	1.836	0.572
18									0.724	-0.121	2770.747	370.772
19										-0.048	3656.975	466.868
20											85.837	5.480

Table A-6

DATA FILE: JS05.DAT .
AV SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 197 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.065	0.342	0.181	-0.118	0.017	0.135	0.133	0.185	0.178
2		0.193	0.200	0.270	0.232	-0.052	0.364	0.157	-0.140
3			0.287	-0.012	0.075	0.049	0.093	0.067	0.060
4				0.067	0.128	-0.028	0.193	0.036	-0.096
5					0.522	-0.079	0.185	-0.116	-0.100
6						-0.041	0.146	-0.075	-0.100
7							-0.154	0.314	0.458
8								0.100	-0.110
9									0.234
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.097	0.103	0.040	0.071	0.093	-0.029	-0.148	-0.018	-0.053	0.113	59.244	4.546
2	0.406	0.331	0.453	0.361	0.285	0.386	-0.100	-0.151	-0.193	0.357	58.279	4.676
3	0.119	0.149	0.035	-0.026	0.076	-0.041	-0.028	0.040	-0.010	0.161	56.117	3.495
4	0.153	0.099	-0.005	0.156	0.164	0.178	0.067	0.069	0.072	0.163	55.406	4.626
5	0.137	-0.027	0.050	0.064	0.065	0.138	-0.015	-0.146	-0.111	0.118	54.766	5.924
6	0.160	0.059	0.108	0.233	0.138	0.147	-0.093	-0.135	-0.094	0.135	53.523	6.647
7	-0.191	0.022	0.101	-0.035	0.035	-0.118	-0.105	-0.145	-0.219	0.085	57.746	6.738
8	0.239	0.178	0.268	0.329	0.260	0.346	-0.083	-0.036	0.000	0.334	59.274	5.137
9	0.093	0.197	0.195	0.223	0.313	0.152	-0.153	-0.238	-0.333	0.033	60.437	5.610
10	-0.215	0.121	0.047	-0.107	0.039	-0.123	-0.056	-0.170	-0.139	0.167	59.751	5.749
11		0.389	0.335	0.365	0.311	0.490	-0.139	-0.120	-0.156	0.196	0.737	0.124
12			0.395	0.376	0.345	0.392	-0.146	-0.199	-0.212	0.213	0.764	0.115
13				0.535	0.418	0.409	-0.276	-0.331	-0.339	0.270	0.834	0.107
14					0.421	0.480	-0.235	-0.209	-0.256	0.224	0.743	0.147
15						0.398	-0.106	-0.222	-0.269	0.157	0.664	0.229
16							-0.116	-0.251	-0.216	0.251	0.793	0.141
17								0.306	0.345	-0.100	1.681	0.472
18									0.775	-0.089	2630.754	306.586
19										-0.146	3451.591	407.672
20											89.912	4.173

Table A-7

DATA FILE: JS06.DAT .
EM SCHOOL DATA
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 805 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.215	0.554	0.340	-0.091	0.020	0.406	0.039	0.423	0.401
2		0.300	0.281	0.203	0.228	0.226	0.224	0.339	0.237
3			0.430	-0.051	0.082	0.336	0.092	0.380	0.333
4				0.123	0.162	0.181	0.136	0.255	0.217
5					0.552	-0.027	0.225	-0.025	-0.077
6						0.036	0.193	0.044	0.021
7							-0.044	0.448	0.496
8								0.160	0.109
9									0.448
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.078	0.180	0.227	0.209	0.260	0.043	-0.151	-0.107	-0.193	0.229	50.966	6.666
2	0.343	0.370	0.241	0.271	0.302	0.349	-0.112	-0.171	-0.183	0.331	52.457	6.209
3	0.159	0.248	0.188	0.151	0.223	0.063	-0.171	-0.170	-0.206	0.212	50.981	5.291
4	0.143	0.185	0.085	0.112	0.149	0.121	-0.055	-0.077	-0.121	0.170	51.867	5.964
5	0.176	0.102	0.014	0.066	0.027	0.191	-0.103	-0.199	-0.167	0.114	53.739	6.615
6	0.260	0.190	0.114	0.149	0.091	0.260	-0.147	-0.165	-0.156	0.186	51.565	6.733
7	0.103	0.242	0.244	0.263	0.281	0.107	-0.198	-0.154	-0.208	0.194	50.108	7.770
8	0.226	0.229	0.180	0.191	0.199	0.271	0.002	-0.073	-0.113	0.255	55.554	5.016
9	0.245	0.376	0.375	0.403	0.382	0.242	-0.192	-0.207	-0.278	0.276	52.407	7.166
10	0.098	0.153	0.204	0.214	0.258	0.109	-0.009	-0.008	-0.088	0.284	49.822	7.735
11		0.399	0.366	0.419	0.352	0.517	-0.215	-0.299	-0.306	0.161	0.672	0.128
12			0.457	0.437	0.430	0.394	-0.229	-0.292	-0.315	0.230	0.657	0.179
13				0.499	0.401	0.361	-0.241	-0.275	-0.312	0.204	0.744	0.123
14					0.441	0.437	-0.301	-0.278	-0.338	0.180	0.599	0.176
15						0.332	-0.165	-0.226	-0.246	0.214	0.477	0.233
16							-0.180	-0.279	-0.309	0.242	0.714	0.166
17								0.324	0.337	-0.009	1.948	0.700
18									0.711	-0.101	2778.937	399.433
19										-0.132	3691.226	457.474
20											87.904	4.730

Table A-8

DATA FILE: JS07.DAT .
EN SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 781 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.395	0.574	0.404	-0.009	0.050	0.410	0.305	0.497	0.488
2		0.378	0.297	0.274	0.278	0.259	0.504	0.438	0.306
3			0.452	-0.015	0.104	0.320	0.225	0.373	0.366
4				0.127	0.175	0.208	0.250	0.268	0.264
5					0.489	-0.145	0.308	-0.028	-0.052
6						0.004	0.262	0.124	0.081
7							-0.153	0.443	0.508
8								0.250	0.135
9									0.480
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.194	0.320	0.328	0.321	0.347	0.179	-0.197	-0.091	-0.177	0.417	49.881	7.244
2	0.433	0.469	0.397	0.331	0.381	0.403	-0.150	-0.182	-0.262	0.421	50.703	6.948
3	0.210	0.322	0.237	0.220	0.296	0.155	-0.110	-0.067	-0.149	0.344	50.859	5.339
4	0.191	0.259	0.196	0.160	0.207	0.155	-0.075	-0.111	-0.115	0.316	51.261	6.304
5	0.150	0.060	0.016	-0.011	0.002	0.155	-0.064	-0.128	-0.100	0.096	52.026	7.105
6	0.230	0.152	0.092	0.099	0.106	0.235	-0.126	-0.129	-0.162	0.168	50.851	6.500
7	0.061	0.165	0.223	0.225	0.316	0.053	-0.152	-0.115	-0.144	0.390	56.223	6.986
8	0.329	0.360	0.320	0.250	0.246	0.353	-0.083	-0.077	-0.130	0.288	52.087	6.465
9	0.254	0.378	0.435	0.418	0.433	0.257	-0.210	-0.268	-0.320	0.421	52.741	7.829
10	0.128	0.245	0.280	0.241	0.296	0.104	-0.075	-0.097	-0.121	0.421	51.298	7.611
11		0.483	0.391	0.425	0.396	0.602	-0.194	-0.260	-0.272	0.188	0.649	0.136
12			0.481	0.472	0.406	0.485	-0.186	-0.230	-0.261	0.301	0.611	0.205
13				0.547	0.474	0.433	-0.202	-0.223	-0.267	0.312	0.737	0.126
14					0.461	0.441	-0.263	-0.239	-0.282	0.267	0.600	0.184
15						0.380	-0.152	-0.230	-0.306	0.323	0.464	0.236
16							-0.218	-0.286	-0.288	0.219	0.677	0.186
17								0.349	0.379	-0.162	1.984	0.659
18									0.712	-0.149	2783.830	393.784
19										-0.195	3693.070	453.354
20											84.841	4.925

Table A-9

DATA FILE: JS08.DAT .
FC SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 727 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.032	0.412	0.239	-0.037	-0.050	0.152	0.067	0.221	0.131
2		0.144	0.158	0.238	0.218	0.122	0.273	0.186	-0.007
3			0.415	-0.053	-0.019	0.126	0.033	0.103	0.129
4				-0.021	0.072	0.081	0.067	0.014	0.108
5					0.543	-0.072	0.158	-0.043	-0.116
6						-0.039	0.151	0.032	-0.064
7							-0.195	0.359	0.450
8								0.104	-0.208
9									0.134
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	-0.021	0.128	0.086	0.108	0.113	0.002	-0.068	-0.085	-0.105	0.110	58.777	4.678
2	0.285	0.260	0.277	0.156	0.244	0.344	-0.101	-0.080	-0.091	0.266	57.309	4.836
3	0.040	0.105	0.031	0.015	0.088	0.009	-0.018	-0.003	-0.050	0.136	55.743	3.926
4	0.069	0.052	0.049	0.059	0.107	0.051	-0.075	-0.000	-0.049	0.185	55.103	4.563
5	0.113	-0.000	0.019	0.045	0.010	0.118	-0.052	-0.155	-0.116	0.116	53.982	6.217
6	0.156	0.048	0.090	0.146	0.100	0.193	-0.112	-0.244	-0.239	0.174	52.779	6.649
7	-0.050	0.070	0.060	0.137	0.184	-0.001	0.035	0.025	-0.035	0.181	58.344	6.393
8	0.183	0.172	0.181	0.066	0.102	0.227	-0.039	-0.110	-0.100	0.254	58.087	5.409
9	0.046	0.197	0.326	0.275	0.316	0.180	-0.063	-0.210	-0.215	0.230	59.564	6.150
10	-0.070	-0.045	-0.030	0.049	0.067	-0.100	0.031	0.061	0.013	0.175	59.083	5.656
11		0.333	0.296	0.287	0.294	0.510	-0.201	-0.280	-0.230	0.098	0.724	0.122
12			0.362	0.319	0.296	0.349	-0.169	-0.209	-0.194	0.173	0.754	0.130
13				0.420	0.348	0.438	-0.160	-0.240	-0.218	0.203	0.819	0.101
14					0.386	0.432	-0.231	-0.227	-0.249	0.185	0.714	0.156
15						0.369	-0.118	-0.242	-0.249	0.211	0.646	0.235
16							-0.181	-0.312	-0.277	0.155	0.774	0.142
17								0.262	0.235	0.008	1.725	0.509
18									0.731	-0.068	2623.172	266.176
19										-0.141	3462.368	393.828
20											83.491	5.328

Table A-10

DATA FILE: JS09.DAT .
GMG SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 393 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	-0.010	0.410	0.320	-0.121	-0.015	0.303	-0.007	0.305	0.229
2		0.126	0.150	0.201	0.158	0.026	0.239	0.199	-0.151
3			0.449	-0.019	0.052	0.216	0.016	0.171	0.143
4				0.020	0.202	0.083	0.016	0.145	0.077
5					0.484	-0.174	0.335	-0.084	-0.169
6						-0.036	0.207	0.035	-0.027
7							-0.250	0.455	0.515
8								0.027	-0.234
9									0.372
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.053	0.052	0.142	0.155	0.165	0.065	-0.117	-0.138	-0.152	0.105	54.697	5.391
2	0.281	0.177	0.175	0.149	0.236	0.233	-0.002	-0.130	-0.117	0.286	52.761	5.428
3	0.086	0.118	0.135	0.127	0.188	0.074	-0.064	-0.061	-0.052	0.236	53.117	4.451
4	0.099	0.117	0.164	0.174	0.143	0.121	-0.095	-0.047	-0.082	0.157	52.941	5.665
5	0.154	0.035	-0.001	-0.015	-0.027	0.201	-0.093	-0.069	-0.051	0.103	53.254	6.485
6	0.221	0.074	0.147	0.187	0.134	0.239	-0.191	-0.173	-0.198	0.126	51.176	6.788
7	0.023	0.014	0.151	0.208	0.233	-0.016	-0.025	-0.098	-0.183	0.189	53.384	7.915
8	0.290	0.197	0.160	0.163	0.140	0.312	-0.192	-0.122	-0.124	0.220	54.463	5.868
9	0.179	0.288	0.380	0.339	0.333	0.175	-0.175	-0.237	-0.338	0.212	54.682	6.555
10	-0.124	-0.009	0.085	0.160	0.125	-0.121	-0.013	-0.031	-0.123	0.108	54.354	6.247
11		0.278	0.385	0.323	0.298	0.514	-0.118	-0.292	-0.267	0.153	0.689	0.121
12			0.436	0.394	0.374	0.341	-0.154	-0.259	-0.280	0.203	0.676	0.170
13				0.541	0.406	0.427	-0.273	-0.391	-0.358	0.194	0.764	0.118
14					0.468	0.376	-0.238	-0.288	-0.362	0.195	0.631	0.177
15						0.297	-0.104	-0.329	-0.350	0.228	0.534	0.239
16							-0.193	-0.384	-0.397	0.258	0.721	0.168
17								0.249	0.290	-0.018	1.745	0.544
18									0.717	-0.162	2669.980	327.026
19										-0.181	3563.469	423.242
20											85.965	4.822

Table A-11

DATA FILE: JS10.DAT .
11H (H) SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 554 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.469	0.683	0.530	0.130	0.088	0.379	0.462	0.536	0.550
2		0.462	0.449	0.434	0.296	0.211	0.679	0.466	0.379
3			0.624	0.153	0.146	0.341	0.371	0.439	0.511
4				0.245	0.206	0.237	0.341	0.375	0.367
5					0.595	-0.086	0.477	0.064	0.064
6						-0.069	0.364	0.054	0.058
7							0.048	0.427	0.556
8								0.431	0.339
9									0.531
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.238	0.403	0.390	0.320	0.329	0.220	-0.258	-0.138	-0.214	0.147	53.446	8.058
2	0.455	0.536	0.449	0.380	0.444	0.466	-0.222	-0.221	-0.228	0.151	53.240	7.072
3	0.208	0.353	0.290	0.275	0.311	0.196	-0.164	-0.147	-0.216	0.162	53.282	6.000
4	0.238	0.377	0.249	0.225	0.256	0.218	-0.154	-0.154	-0.216	0.181	53.103	6.128
5	0.299	0.273	0.193	0.200	0.179	0.322	-0.205	-0.131	-0.100	0.039	53.473	6.744
6	0.317	0.213	0.184	0.247	0.179	0.276	-0.169	-0.145	-0.157	0.050	53.038	6.533
7	0.057	0.107	0.157	0.201	0.178	0.071	-0.008	-0.091	-0.131	0.183	54.316	7.374
8	0.431	0.494	0.452	0.395	0.441	0.442	-0.291	-0.187	-0.202	0.190	53.051	8.302
9	0.267	0.445	0.461	0.428	0.463	0.334	-0.249	-0.252	-0.296	0.226	55.897	7.182
10	0.189	0.279	0.281	0.329	0.272	0.186	-0.119	-0.125	-0.190	0.201	52.771	7.993
11		0.480	0.405	0.370	0.392	0.525	-0.225	-0.234	-0.271	0.137	0.690	0.137
12			0.458	0.422	0.461	0.469	-0.193	-0.199	-0.229	0.127	0.651	0.205
13				0.554	0.500	0.429	-0.272	-0.347	-0.286	0.162	0.756	0.132
14					0.482	0.490	-0.248	-0.300	-0.332	0.221	0.628	0.201
15						0.441	-0.227	-0.282	-0.297	0.222	0.508	0.250
16							-0.253	-0.330	-0.286	0.172	0.723	0.185
17								0.247	0.283	-0.142	1.827	0.553
18									0.702	-0.161	2760.143	340.312
19										-0.204	3622.607	450.096
20											1728.251	335.654

Table A-12

DATA FILE: JS11.DAT .
11H (I) SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 320 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.505	0.673	0.557	0.140	0.140	0.361	0.476	0.562	0.524
2		0.483	0.462	0.351	0.281	0.125	0.645	0.503	0.322
3			0.624	0.169	0.183	0.321	0.349	0.440	0.450
4				0.136	0.236	0.244	0.332	0.402	0.408
5					0.599	-0.162	0.416	0.077	0.040
6						-0.077	0.307	0.106	0.119
7							0.023	0.379	0.527
8								0.478	0.287
9									0.520
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.294	0.391	0.391	0.319	0.408	0.301	-0.189	-0.162	-0.260	0.227	53.325	7.519
2	0.444	0.510	0.470	0.341	0.428	0.432	-0.116	-0.118	-0.179	0.157	54.422	7.149
3	0.254	0.393	0.352	0.208	0.379	0.143	-0.176	-0.152	-0.213	0.200	53.566	5.545
4	0.295	0.384	0.291	0.201	0.323	0.229	-0.165	-0.146	-0.197	0.185	53.534	5.959
5	0.245	0.201	0.151	0.176	0.184	0.207	-0.122	-0.094	-0.071	0.202	53.994	6.507
6	0.229	0.201	0.172	0.183	0.204	0.137	-0.094	-0.110	-0.110	0.146	53.572	6.325
7	-0.042	0.112	0.163	0.129	0.226	0.100	-0.099	-0.078	-0.154	0.101	54.713	7.300
8	0.455	0.474	0.405	0.405	0.491	0.471	-0.073	-0.132	-0.150	0.180	53.797	7.782
9	0.384	0.470	0.528	0.442	0.498	0.416	-0.192	-0.247	-0.295	0.244	56.616	7.267
10	0.132	0.267	0.308	0.237	0.379	0.136	-0.180	-0.157	-0.201	0.207	52.578	7.732
11		0.514	0.439	0.409	0.380	0.561	-0.117	-0.301	-0.249	0.236	0.709	0.136
12			0.517	0.459	0.505	0.487	-0.193	-0.345	-0.289	0.147	0.686	0.185
13				0.621	0.509	0.381	-0.215	-0.320	-0.299	0.235	0.782	0.131
14					0.459	0.465	-0.165	-0.273	-0.303	0.191	0.668	0.190
15						0.464	-0.165	-0.329	-0.346	0.264	0.536	0.256
16							-0.109	-0.297	-0.299	0.171	0.762	0.156
17								0.317	0.331	-0.210	1.862	0.601
18									0.753	-0.306	2744.203	374.216
19										-0.337	3588.446	454.374
20											1734.850	333.830

Table A-13

DATA FILE: JS12.DAT .
BT/MM SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 837 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.397	0.618	0.441	0.043	0.067	0.460	0.216	0.509	0.500
2		0.379	0.302	0.309	0.243	0.286	0.492	0.467	0.324
3			0.499	-0.015	0.046	0.418	0.166	0.418	0.487
4				0.089	0.208	0.254	0.183	0.304	0.319
5					0.557	-0.094	0.360	0.007	-0.043
6						0.015	0.250	0.102	0.054
7							-0.126	0.451	0.545
8								0.233	0.115
9									0.474
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.150	0.289	0.320	0.339	0.283	0.190	-0.201	-0.155	-0.203	0.300	50.947	7.674
2	0.396	0.442	0.459	0.421	0.381	0.437	-0.167	-0.184	-0.218	0.276	50.836	6.973
3	0.180	0.237	0.276	0.253	0.261	0.124	-0.171	-0.129	-0.194	0.186	50.827	5.556
4	0.146	0.148	0.170	0.160	0.212	0.115	-0.109	-0.107	-0.163	0.211	51.027	6.083
5	0.188	0.079	0.066	0.106	0.028	0.225	-0.099	-0.104	-0.072	0.102	52.896	6.667
6	0.238	0.118	0.145	0.188	0.142	0.250	-0.167	-0.185	-0.155	0.149	51.183	6.536
7	0.022	0.164	0.262	0.268	0.230	0.048	-0.146	-0.154	-0.197	0.271	54.428	7.323
8	0.341	0.316	0.329	0.293	0.306	0.366	-0.061	-0.085	-0.108	0.191	53.569	6.350
9	0.248	0.374	0.434	0.430	0.390	0.296	-0.253	-0.252	-0.289	0.292	52.806	7.577
10	0.045	0.162	0.261	0.252	0.226	0.089	-0.116	-0.096	-0.151	0.262	51.375	7.900
11		0.417	0.385	0.435	0.374	0.550	-0.256	-0.266	-0.280	0.130	0.660	0.135
12			0.453	0.515	0.411	0.443	-0.252	-0.250	-0.302	0.254	0.636	0.191
13				0.590	0.460	0.467	-0.264	-0.268	-0.292	0.239	0.741	0.128
14					0.490	0.540	-0.351	-0.312	-0.350	0.292	0.605	0.189
15						0.400	-0.248	-0.293	-0.325	0.163	0.485	0.237
16							-0.275	-0.291	-0.316	0.180	0.687	0.185
17								0.361	0.334	-0.127	1.883	0.646
18									0.700	-0.157	2773.877	379.968
19										-0.112	3677.408	461.697
20											82.476	6.495

Table A-14

DATA FILE: JS13.DAT .
OS SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 622 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.354	0.559	0.375	-0.040	-0.139	0.435	0.217	0.492	0.462
2		0.319	0.238	0.153	0.026	0.324	0.497	0.487	0.249
3			0.447	-0.005	-0.160	0.366	0.106	0.370	0.342
4				-0.049	-0.095	0.228	0.051	0.287	0.276
5					0.426	-0.033	0.073	-0.001	-0.030
6						-0.053	-0.163	-0.043	-0.098
7							0.122	0.481	0.494
8								0.326	0.160
9									0.441
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.186	0.298	0.389	0.343	0.329	0.214	-0.210	-0.214	-0.231	0.292	50.021	7.303
2	0.371	0.497	0.469	0.347	0.436	0.479	-0.137	-0.196	-0.280	0.461	50.170	6.938
3	0.151	0.222	0.288	0.250	0.278	0.137	-0.109	-0.144	-0.179	0.228	52.611	4.858
4	0.085	0.178	0.184	0.147	0.188	0.071	-0.120	-0.105	-0.103	0.215	53.121	4.952
5	0.062	0.040	0.001	0.038	-0.005	0.096	-0.072	-0.078	-0.151	0.135	55.892	5.775
6	-0.056	-0.033	-0.005	-0.015	0.004	0.043	-0.068	-0.107	-0.124	0.134	56.929	5.826
7	0.126	0.207	0.327	0.340	0.278	0.133	-0.159	-0.227	-0.299	0.256	48.929	7.777
8	0.335	0.396	0.308	0.283	0.304	0.386	-0.089	-0.146	-0.135	0.384	54.777	5.801
9	0.293	0.440	0.537	0.502	0.471	0.339	-0.283	-0.344	-0.397	0.392	51.195	7.748
10	0.073	0.204	0.304	0.339	0.260	0.163	-0.163	-0.194	-0.249	0.263	48.902	7.100
11		0.459	0.381	0.376	0.356	0.507	-0.233	-0.236	-0.211	0.278	0.687	0.126
12			0.526	0.493	0.448	0.497	-0.245	-0.304	-0.303	0.365	0.647	0.190
13				0.619	0.431	0.457	-0.266	-0.303	-0.352	0.361	0.736	0.128
14					0.421	0.468	-0.339	-0.367	-0.401	0.317	0.593	0.190
15						0.376	-0.160	-0.270	-0.278	0.338	0.473	0.229
16							-0.249	-0.317	-0.317	0.391	0.709	0.173
17								0.303	0.290	-0.139	1.861	0.608
18									0.745	-0.190	2698.407	337.652
19										-0.250	3605.212	458.299
20											88.576	4.500

Table A-15

DATA FILE: JS14.DAT .
RM SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 250 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.428	0.574	0.433	-0.147	-0.131	0.463	0.368	0.439	0.492
2		0.399	0.391	0.229	0.080	0.233	0.524	0.419	0.238
3			0.550	-0.133	-0.054	0.355	0.257	0.346	0.418
4				-0.030	-0.120	0.276	0.249	0.301	0.240
5					0.425	-0.038	0.227	-0.016	-0.152
6						-0.041	0.029	-0.061	-0.037
7							0.096	0.441	0.613
8								0.351	0.129
9									0.430
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.134	0.371	0.345	0.252	0.311	0.146	-0.275	-0.222	-0.180	0.370	51.488	7.316
2	0.352	0.465	0.381	0.234	0.308	0.362	-0.164	-0.224	-0.179	0.423	51.176	7.435
3	0.088	0.216	0.214	0.147	0.232	0.020	-0.124	-0.088	-0.087	0.331	52.184	5.415
4	0.094	0.187	0.136	0.066	0.176	-0.039	-0.050	-0.049	-0.041	0.243	52.948	5.692
5	0.089	0.005	0.097	0.054	-0.009	0.206	-0.073	-0.049	-0.036	0.079	54.640	6.691
6	0.173	0.074	0.055	0.187	-0.010	0.171	-0.093	-0.149	-0.153	0.102	54.800	5.448
7	-0.021	0.176	0.157	0.212	0.218	0.087	-0.184	-0.168	-0.231	0.146	50.828	7.747
8	0.335	0.419	0.406	0.231	0.273	0.364	-0.099	-0.066	-0.093	0.330	53.640	6.632
9	0.249	0.501	0.393	0.330	0.413	0.282	-0.312	-0.301	-0.322	0.278	52.504	7.501
10	0.032	0.250	0.253	0.245	0.287	0.094	-0.141	-0.185	-0.202	0.242	50.136	7.571
11		0.437	0.389	0.482	0.333	0.572	-0.235	-0.290	-0.312	0.277	0.669	0.137
12			0.477	0.431	0.409	0.472	-0.265	-0.335	-0.284	0.270	0.633	0.189
13				0.492	0.441	0.452	-0.318	-0.384	-0.373	0.304	0.727	0.118
14					0.411	0.498	-0.348	-0.338	-0.357	0.220	0.581	0.192
15						0.431	-0.238	-0.319	-0.287	0.254	0.459	0.227
16							-0.274	-0.363	-0.355	0.270	0.696	0.179
17								0.380	0.320	0.009	1.915	0.652
18									0.761	-0.096	2854.634	416.010
19										-0.093	3719.690	476.153
20											94.715	2.628

Table A-16

DATA FILE: JS15.DAT .
13F SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 819 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.456	0.649	0.436	0.035	-0.047	0.450	0.375	0.457	0.489
2		0.444	0.405	0.248	0.095	0.260	0.537	0.340	0.356
3			0.565	0.039	0.002	0.404	0.304	0.381	0.451
4				0.129	0.058	0.268	0.281	0.295	0.315
5					0.516	-0.054	0.294	-0.067	0.030
6						-0.054	0.140	-0.108	-0.009
7							0.031	0.492	0.512
8								0.248	0.254
9									0.493
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.171	0.322	0.314	0.310	0.309	0.143	-0.237	-0.178	-0.244	0.327	53.928	7.445
2	0.331	0.369	0.403	0.324	0.341	0.322	-0.110	-0.207	-0.212	0.404	55.294	6.283
3	0.152	0.294	0.229	0.275	0.283	0.138	-0.174	-0.168	-0.202	0.324	53.479	5.595
4	0.202	0.263	0.244	0.207	0.192	0.145	-0.155	-0.129	-0.126	0.345	53.796	5.695
5	0.227	0.121	0.110	0.064	0.037	0.209	-0.087	-0.125	-0.063	0.189	54.819	6.190
6	0.187	0.078	0.066	0.078	0.071	0.170	-0.069	-0.107	-0.093	0.210	54.366	6.490
7	0.049	0.159	0.202	0.264	0.255	0.056	-0.150	-0.150	-0.191	0.294	53.665	8.084
8	0.299	0.307	0.352	0.270	0.306	0.293	-0.121	-0.175	-0.168	0.347	56.263	6.896
9	0.157	0.317	0.362	0.402	0.384	0.188	-0.217	-0.231	-0.306	0.323	56.701	6.880
10	0.074	0.215	0.271	0.296	0.291	0.156	-0.143	-0.196	-0.226	0.297	52.709	7.658
11		0.456	0.420	0.387	0.321	0.531	-0.185	-0.309	-0.256	0.331	0.690	0.142
12			0.475	0.461	0.422	0.436	-0.228	-0.309	-0.314	0.373	0.645	0.218
13				0.525	0.479	0.452	-0.209	-0.322	-0.318	0.396	0.753	0.128
14					0.532	0.482	-0.284	-0.366	-0.398	0.384	0.613	0.205
15						0.436	-0.182	-0.303	-0.316	0.377	0.500	0.254
16							-0.195	-0.373	-0.322	0.335	0.714	0.183
17								0.272	0.277	-0.196	1.817	0.580
18									0.730	-0.271	2824.191	439.795
19										-0.259	3702.347	483.900
20											90.410	4.127

Table A-17

DATA FILE: JS16.DAT .
19K SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 1106 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.452	0.638	0.485	0.069	0.070	0.420	0.442	0.553	0.542
2		0.393	0.334	0.349	0.252	0.158	0.633	0.397	0.316
3			0.518	0.052	0.102	0.345	0.311	0.432	0.416
4				0.112	0.163	0.247	0.303	0.347	0.335
5					0.542	-0.123	0.350	-0.016	-0.027
6						-0.094	0.260	0.030	-0.004
7							0.025	0.451	0.571
8								0.364	0.245
9									0.515
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.268	0.390	0.439	0.425	0.399	0.283	-0.282	-0.250	-0.291	0.141	52.680	7.593
2	0.456	0.468	0.446	0.394	0.433	0.478	-0.193	-0.242	-0.245	0.124	52.802	7.188
3	0.216	0.340	0.324	0.312	0.291	0.235	-0.201	-0.231	-0.293	0.067	52.841	5.350
4	0.191	0.285	0.257	0.245	0.225	0.188	-0.144	-0.209	-0.205	0.096	53.187	5.783
5	0.237	0.169	0.124	0.044	0.066	0.277	-0.101	-0.157	-0.092	0.119	53.599	6.853
6	0.238	0.167	0.147	0.139	0.096	0.233	-0.135	-0.207	-0.177	0.113	53.012	6.543
7	0.030	0.153	0.255	0.254	0.228	0.064	-0.093	-0.089	-0.180	0.067	54.090	7.873
8	0.420	0.436	0.463	0.389	0.412	0.429	-0.210	-0.251	-0.221	0.153	53.103	7.727
9	0.269	0.414	0.465	0.449	0.435	0.295	-0.222	-0.258	-0.337	0.105	55.060	7.516
10	0.120	0.255	0.305	0.339	0.301	0.122	-0.164	-0.183	-0.256	0.073	52.093	7.728
11		0.454	0.438	0.427	0.368	0.564	-0.246	-0.295	-0.290	0.113	0.682	0.139
12			0.489	0.491	0.455	0.457	-0.216	-0.298	-0.302	0.052	0.629	0.204
13				0.592	0.494	0.480	-0.305	-0.308	-0.327	0.119	0.742	0.130
14					0.513	0.522	-0.332	-0.305	-0.338	0.124	0.610	0.204
15						0.446	-0.258	-0.278	-0.328	0.084	0.496	0.247
16							-0.246	-0.367	-0.343	0.116	0.718	0.186
17								0.348	0.355	-0.084	1.704	0.603
18									0.710	-0.099	2741.069	347.388
19										-0.083	3549.440	453.307
20											1.884	0.106

Table A-18

DATA FILE: JS17.DAT .
272 (1) SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 484 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.277	0.484	0.268	-0.044	-0.023	0.382	0.313	0.434	0.477
2		0.205	0.113	0.047	0.089	0.170	0.513	0.356	0.256
3			0.316	0.043	0.062	0.260	0.309	0.333	0.320
4				0.080	0.176	0.076	0.220	0.163	0.134
5					0.315	-0.096	0.132	-0.049	-0.115
6						-0.078	0.184	0.011	0.013
7							0.046	0.521	0.588
8								0.336	0.188
9									0.518
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.087	0.227	0.291	0.222	0.233	0.089	-0.160	-0.191	-0.237	0.211	55.217	6.451
2	0.296	0.310	0.357	0.358	0.258	0.299	-0.032	-0.167	-0.193	0.270	58.426	5.111
3	0.074	0.191	0.196	0.184	0.151	0.081	-0.066	-0.082	-0.140	0.265	55.893	3.815
4	0.020	0.046	0.009	0.085	0.057	-0.023	0.042	-0.026	-0.023	0.164	55.979	4.357
5	0.096	0.064	0.032	0.052	-0.002	0.125	-0.047	-0.094	0.005	0.034	56.339	6.493
6	0.061	0.015	-0.024	0.071	-0.019	0.066	-0.073	-0.001	0.051	0.059	55.866	7.659
7	-0.009	0.117	0.201	0.227	0.213	0.016	-0.224	-0.218	-0.333	0.218	52.607	7.737
8	0.318	0.407	0.337	0.373	0.295	0.309	-0.010	-0.139	-0.126	0.251	59.242	6.318
9	0.151	0.338	0.411	0.418	0.390	0.189	-0.231	-0.339	-0.415	0.293	56.915	7.445
10	0.044	0.197	0.288	0.239	0.259	0.122	-0.162	-0.270	-0.375	0.261	52.434	7.598
11		0.325	0.299	0.321	0.197	0.505	-0.182	-0.131	-0.137	0.166	0.762	0.113
12			0.471	0.473	0.347	0.403	-0.063	-0.147	-0.200	0.177	0.760	0.130
13				0.513	0.438	0.464	-0.196	-0.268	-0.302	0.220	0.807	0.112
14					0.413	0.468	-0.264	-0.263	-0.325	0.256	0.683	0.184
15						0.325	-0.194	-0.310	-0.332	0.273	0.595	0.247
16							-0.122	-0.176	-0.180	0.225	0.814	0.126
17								0.246	0.340	-0.168	1.823	0.545
18									0.744	-0.197	2783.333	414.728
19										-0.201	3671.466	504.741
20											83.260	5.520

Table A-19

DATA FILE: JS18.DAT .
732 SCHOOL STATISTICS
INTERCORRELATIONS, MEANS AND STANDARD DEVIATIONS
FOR 20 VARIABLES IN A SAMPLE OF 421 OBSERVATIONS.

	2	3	4	5	6	7	8	9	10
1	0.323	0.445	0.298	-0.110	-0.149	0.352	0.204	0.453	0.371
2		0.164	0.204	0.151	0.073	0.251	0.446	0.398	0.188
3			0.326	-0.062	0.018	0.201	0.124	0.243	0.158
4				-0.013	0.100	0.095	0.147	0.186	0.116
5					0.227	-0.072	0.234	-0.049	-0.102
6						-0.062	0.058	-0.141	-0.146
7							0.072	0.462	0.480
8								0.305	0.124
9									0.410
10									

	11	12	13	14	15	16	17	18	19	20	MEAN:	SD:
1	0.113	0.173	0.210	0.176	0.258	0.056	-0.136	-0.132	-0.140	0.327	51.544	6.762
2	0.287	0.246	0.319	0.270	0.251	0.395	-0.161	-0.158	-0.245	0.409	53.591	6.149
3	0.081	0.150	0.126	0.074	0.185	0.028	-0.031	0.015	-0.047	0.273	53.183	5.642
4	0.072	0.100	0.062	0.008	0.094	0.056	-0.043	-0.064	-0.029	0.272	54.052	5.063
5	0.106	0.075	-0.036	-0.020	-0.051	0.123	0.066	0.024	0.048	0.129	57.278	5.367
6	0.039	0.009	-0.043	-0.004	-0.009	0.068	0.026	-0.009	-0.005	0.091	57.264	7.324
7	0.044	0.123	0.143	0.246	0.237	0.064	-0.136	-0.212	-0.314	0.190	47.112	6.736
8	0.226	0.272	0.250	0.216	0.251	0.295	-0.033	-0.112	-0.143	0.369	55.713	6.608
9	0.132	0.295	0.351	0.386	0.355	0.246	-0.264	-0.318	-0.388	0.252	50.708	7.382
10	0.002	0.115	0.180	0.216	0.125	0.044	-0.138	-0.139	-0.217	0.143	47.846	7.553
11		0.361	0.319	0.346	0.343	0.539	-0.136	-0.166	-0.178	0.282	0.715	0.119
12			0.400	0.402	0.343	0.357	-0.147	-0.188	-0.180	0.287	0.674	0.168
13				0.495	0.406	0.421	-0.272	-0.274	-0.326	0.226	0.737	0.121
14					0.445	0.470	-0.295	-0.342	-0.350	0.175	0.594	0.189
15						0.348	-0.187	-0.236	-0.283	0.270	0.456	0.225
16							-0.227	-0.289	-0.285	0.224	0.744	0.154
17								0.298	0.275	-0.032	2.057	0.617
18									0.717	0.002	3054.077	505.946
19										-0.024	3973.984	487.646
20											81.672	6.276

Table A-20

Combined Schools Predictor Matrix

Means, Standard Deviations, and Intercorrelations for a Combined Schools Predictor Matrix of 9038 Subjects in Eighteen Schools

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:
GS:	0.420	0.607	0.428	0.016	0.012	0.407	0.335	0.513	0.509
AR:		0.404	0.346	0.269	0.198	0.228	0.533	0.442	0.308
WK:			0.518	0.044	0.089	0.313	0.271	0.396	0.400
PC:				0.121	0.166	0.185	0.254	0.292	0.276
NO:					0.525	-0.123	0.310	-0.022	-0.058
CS:						-0.090	0.211	0.014	-0.029
AS:							-0.022	0.484	0.562
MK:								0.296	0.179
MC:									0.504
EI:									

	CT:	SM:	FR:	ID:	AO:	SO:	T1:	T2:	TI:	MEAN:	SD:
GS:	0.198	0.199	0.333	0.352	0.328	0.340	-0.178	-0.229	-0.223	52.995	7.384
AR:	0.429	0.406	0.445	0.424	0.361	0.390	-0.175	-0.208	-0.149	53.382	6.897
WK:	0.166	0.200	0.301	0.270	0.243	0.285	-0.130	-0.181	-0.149	52.888	5.375
PC:	0.163	0.192	0.243	0.201	0.180	0.212	-0.103	-0.127	-0.107	53.095	5.832
NO:	0.219	0.196	0.117	0.072	0.063	0.042	-0.097	-0.068	-0.076	54.059	6.606
CS:	0.212	0.212	0.118	0.094	0.120	0.083	-0.104	-0.108	-0.104	53.172	6.876
AS:	0.066	0.031	0.159	0.241	0.259	0.260	-0.168	-0.223	-0.144	53.580	8.014
MK:	0.373	0.348	0.381	0.357	0.308	0.324	-0.135	-0.139	-0.107	54.883	6.874
MC:	0.285	0.241	0.391	0.450	0.436	0.437	-0.275	-0.339	-0.238	54.790	7.669
EI:	0.119	0.090	0.230	0.286	0.292	0.292	-0.165	-0.219	-0.136	52.345	7.892
CT:		0.558	0.458	0.456	0.486	0.406	-0.306	-0.307	-0.221	0.725	0.175
SM:			0.445	0.398	0.400	0.358	-0.250	-0.254	-0.208	0.688	0.134
FR:				0.489	0.474	0.433	-0.260	-0.274	-0.206	0.666	0.189
ID:					0.565	0.477	-0.299	-0.318	-0.250	0.759	0.126
AO:						0.489	-0.308	-0.347	-0.295	0.627	0.192
SO:							-0.287	-0.318	-0.199	0.515	0.247
T1:								0.730	0.320	2762.943	385.782
T2:									0.334	3638.037	468.824
TI:										1.841	0.609

Table A-21

Population #2 Matrix:
Population Intercorrelations, Means, and Standard
Deviations for the Combined ASVAB and ECAT tests.

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:
GS:	0.611	0.720	0.608	0.275	0.249	0.520	0.554	0.638	0.625
AR:		0.596	0.574	0.470	0.395	0.400	0.707	0.613	0.487
WK:			0.732	0.324	0.328	0.437	0.497	0.547	0.534
PC:				0.396	0.386	0.339	0.500	0.485	0.444
NO:					0.640	0.047	0.496	0.228	0.145
CS:						0.058	0.408	0.221	0.147
AS:							0.197	0.618	0.669
MK:								0.494	0.370
MC:									0.630
EI:									

	CT:	SM:	FR:	ID:	AO:	SO:	T1:	T2:	TI:	MEAN:	SD:
GS:	0.370	0.369	0.496	0.499	0.469	0.488	-0.283	-0.343	-0.307	50.615	8.773
AR:	0.557	0.536	0.590	0.565	0.507	0.537	-0.291	-0.337	-0.257	50.664	8.645
WK:	0.342	0.372	0.470	0.427	0.395	0.439	-0.243	-0.301	-0.247	51.311	7.354
PC:	0.349	0.375	0.438	0.385	0.354	0.392	-0.226	-0.264	-0.218	51.156	7.964
NO:	0.370	0.352	0.306	0.254	0.235	0.225	-0.206	-0.195	-0.180	52.512	8.013
CS:	0.348	0.348	0.286	0.253	0.263	0.239	-0.200	-0.215	-0.192	52.266	7.812
AS:	0.206	0.170	0.307	0.377	0.386	0.391	-0.256	-0.322	-0.222	51.409	9.168
MK:	0.516	0.494	0.540	0.511	0.462	0.482	-0.254	-0.276	-0.221	51.210	8.689
MC:	0.427	0.385	0.527	0.570	0.553	0.559	-0.365	-0.435	-0.319	51.941	9.127
EI:	0.269	0.241	0.383	0.425	0.422	0.429	-0.262	-0.325	-0.225	50.333	8.856
CT:		0.628	0.555	0.548	0.568	0.504	-0.374	-0.385	-0.291	0.681	0.191
SM:			0.542	0.497	0.492	0.461	-0.323	-0.336	-0.278	0.657	0.146
FR:				0.587	0.568	0.540	-0.341	-0.366	-0.284	0.612	0.212
ID:					0.641	0.572	-0.373	-0.403	-0.320	0.723	0.140
AO:						0.577	-0.378	-0.424	-0.358	0.577	0.210
SO:							-0.361	-0.402	-0.274	0.448	0.273
T1:								0.750	0.362	2818.957	399.981
T2:									0.380	3714.969	491.781
TI:										1.914	0.626

Table A-22

Matrix of Fully Corrected School Validities

Validities Corrected for Restriction in Range and Criterion Unreliability for the ASVAB and ECAT Tests and School Sample Sizes for Eighteen Joint Service Schools

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.630	0.729	0.527	0.576	0.460	0.502	0.345	0.780	0.500	0.508	72
AE:	0.586	0.579	0.545	0.467	0.318	0.356	0.450	0.564	0.547	0.536	173
AMS:	0.707	0.672	0.696	0.601	0.404	0.434	0.531	0.616	0.652	0.600	244
AO:	0.547	0.588	0.503	0.507	0.405	0.410	0.358	0.618	0.466	0.464	233
AV:	0.611	0.734	0.607	0.578	0.398	0.372	0.421	0.684	0.526	0.594	197
EM:	0.538	0.618	0.488	0.452	0.360	0.350	0.352	0.584	0.518	0.471	805
EN:	0.627	0.632	0.579	0.545	0.326	0.303	0.576	0.552	0.634	0.615	781
FC:	0.610	0.686	0.594	0.589	0.405	0.387	0.461	0.657	0.626	0.586	727
GMG:	0.564	0.679	0.598	0.535	0.367	0.332	0.450	0.613	0.564	0.521	393
11H-H:	0.248	0.238	0.251	0.267	0.085	0.096	0.291	0.249	0.316	0.283	554
11H-I:	0.320	0.289	0.295	0.291	0.302	0.225	0.244	0.270	0.347	0.289	320
BT/MM:	0.456	0.441	0.359	0.382	0.244	0.243	0.405	0.410	0.458	0.424	837
OS:	0.590	0.702	0.582	0.597	0.485	0.517	0.364	0.695	0.579	0.480	622
RM:	0.619	0.655	0.591	0.537	0.404	0.419	0.312	0.572	0.530	0.459	250
13F:	0.583	0.677	0.578	0.598	0.426	0.465	0.457	0.610	0.608	0.498	819
19K:	0.191	0.186	0.135	0.160	0.182	0.168	0.123	0.201	0.171	0.125	1106
272-1:	0.572	0.644	0.640	0.593	0.345	0.329	0.435	0.539	0.573	0.511	484
732:	0.666	0.753	0.658	0.652	0.467	0.426	0.410	0.690	0.581	0.496	421

	CT:	SM:	FR:	ID:	AO:	SO:	T1:	T2:	TI:	N;
AC:	0.540	0.502	0.583	0.479	0.526	0.481	-0.225	-0.280	-0.232	72
AE:	0.513	0.469	0.501	0.567	0.536	0.515	-0.362	-0.346	-0.356	173
AMS:	0.421	0.425	0.515	0.540	0.499	0.493	-0.295	-0.348	-0.285	244
AO:	0.411	0.348	0.469	0.464	0.478	0.446	-0.353	-0.317	-0.334	233
AV:	0.519	0.484	0.531	0.535	0.502	0.479	-0.258	-0.371	-0.264	197
EM:	0.447	0.374	0.467	0.463	0.411	0.438	-0.256	-0.291	-0.179	805
EN:	0.410	0.352	0.486	0.506	0.475	0.502	-0.305	-0.359	-0.285	781
FC:	0.457	0.429	0.553	0.549	0.520	0.530	-0.265	-0.358	-0.216	727
GMG:	0.494	0.403	0.527	0.496	0.464	0.491	-0.300	-0.339	-0.189	393
11H-H:	0.232	0.202	0.219	0.252	0.297	0.302	-0.227	-0.272	-0.206	554
11H-I:	0.265	0.311	0.216	0.311	0.287	0.324	-0.364	-0.405	-0.271	320
BT/MM:	0.317	0.279	0.410	0.385	0.417	0.326	-0.260	-0.236	-0.207	837
OS:	0.562	0.513	0.561	0.539	0.505	0.525	-0.288	-0.356	-0.257	622
RM:	0.493	0.487	0.470	0.511	0.448	0.473	-0.207	-0.250	-0.108	250
13F:	0.541	0.522	0.585	0.590	0.565	0.571	-0.370	-0.399	-0.322	819
19K:	0.158	0.155	0.112	0.157	0.169	0.136	-0.128	-0.125	-0.109	1106
272-1:	0.511	0.456	0.493	0.488	0.491	0.537	-0.349	-0.366	-0.342	484
732:	0.508	0.550	0.605	0.550	0.492	0.551	-0.232	-0.266	-0.235	421

Appendix B
ASVAB and ECAT Reliabilities

Table B-1

Paper and Pencil ASVAB Subtest Reliabilities and Standard Deviations; Estimated from Statistics for ASVAB Form 9B

		ASVAB Form 9B Standard Deviations:		ASVAB Form 9B Reliabilities:	
		Sample;	Population;	Sample;	Population;
i:	Test i:	s_i:	S_i:	r_{ii}:	R_{ii}:
1	GS	9.01	10.02	.80	.84
2	AR	8.39	9.30	.82	.85
3	WK	6.83	7.88	.84	.88
4	PC	7.72	8.58	.59	.67
5	NO	7.04	8.03	.82	.86
6	CS	7.85	8.59	.79	.82
7	AS	8.24	8.86	.80	.83
8	MK	8.38	9.12	.85	.87
9	MC	8.40	8.98	.73	.76
10	EI	7.77	8.13	.66	.69

Table B-2

ECAT Sample Standard Deviations amd Reliabilities, and Estimated Population Standard Deviations and Reliabilities

		ECAT Subtest Standard Deviations:		ECAT Subtest Reliabilities:	
		Sample;	Population;	Sample;	Population;
i:	Test i:	s_i:	S_i:	r_{ii}:	R_{ii}:
1	CT	.160	.191	.79	.85
2	SM	.140	.146	.81	.83
3	FR	.199	.212	.75	.78
4	ID	.132	.140	.79	.81
5	AO	.214	.210	.83	.82
6	SO	.258	.273	.75	.78
7	T1	432	399.781	.84	.81
8	T2	531	491.781	.91	.90
9	TI	.568	.626	.80	.84

Appendix C
CAT-ASVAB Reliabilities, Intercorrelations, and Validities

Table C-1

Number of Items, Average Completion Times, and Reliability Function Parameters for CAT-ASVAB Power Tests

Test #:	Test:	Number of Items, $n_{o(i)}$:	Average Completion Time, $t_{o(i)}$:	u_i:	v_i:	w_i:
1	GS	15	4.712	.25813	.77643	1.03190
2	AR	15	20.973	.34615	.75918	1.05059
3	WK	15	4.112	.34779	.99696	1.23127
4	PC	10	13.604	.37594	.98065	1.13405
7	AS	20	6.196	.31249	1.08341	1.26922
8	MK	15	9.461	.58828	1.15528	1.33384
9	MC	15	10.787	.26707	.86810	1.04683
10	EI	15	4.419	.22787	1.12103	1.18516

Table C-2

ASVAB and CAT-ASVAB Reliabilities, and Weights for Estimating CAT-ASVAB Intercorrelations

Test #:	Test:	$r_{c(i)}$:	$r_{p(i)}$:	W_i:
1	GS	.88	.84	1.0235
2	AR	.92	.85	1.0404
3	WK	.91	.88	1.0169
4	PC	.84	.67	1.1197
7	AS	.92	.83	1.0528
8	MK	.93	.87	1.0339
9	MC	.87	.76	1.1447
10	EI	.82	.69	1.0901

Table C-3

Estimated CAT-ASVAB Z-Score Intercorrelations (Mean = 0, SD = 1)
for the 1991 DOD Population of Applicants

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	MEAN:	SD:
GS:	0.652	0.749	0.698	0.282	0.255	0.560	0.588	0.697	0.695	0.000	1.000
AR:		0.631	0.671	0.490	0.412	0.439	0.763	0.682	0.551	0.000	1.000
WK:			0.833	0.329	0.333	0.466	0.522	0.593	0.590	0.000	1.000
PC:				0.444	0.433	0.400	0.580	0.581	0.542	0.000	1.000
NO:					0.640	0.049	0.514	0.243	0.158	0.000	1.000
CS:						0.061	0.422	0.236	0.160	0.000	1.000
AS:							0.214	0.693	0.765	0.000	1.000
MK:								0.546	0.416	0.000	1.000
MC:									0.731	0.000	1.000
EI:										0.000	1.000

Table C-4

Estimated CAT-ASVAB Validities, corrected for Criterion Unreliability and Range Restriction, together with Sample Sizes, in in Eighteen Joint Service Schools

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.645	0.760	0.535	0.646	0.460	0.502	0.363	0.808	0.534	0.553	72
AE:	0.600	0.604	0.553	0.524	0.318	0.356	0.473	0.585	0.584	0.583	173
AMS:	0.724	0.700	0.706	0.674	0.404	0.434	0.558	0.638	0.696	0.653	244
AO:	0.560	0.613	0.511	0.568	0.405	0.410	0.376	0.640	0.497	0.504	233
AV:	0.626	0.764	0.617	0.648	0.398	0.372	0.442	0.709	0.561	0.645	197
EM:	0.551	0.643	0.495	0.507	0.360	0.350	0.370	0.605	0.553	0.512	805
EN:	0.642	0.658	0.588	0.611	0.326	0.303	0.605	0.571	0.676	0.668	781
FC:	0.625	0.714	0.603	0.660	0.405	0.387	0.485	0.681	0.668	0.637	727
GMG:	0.578	0.707	0.607	0.600	0.367	0.332	0.473	0.635	0.602	0.567	393
11H-H:	0.253	0.248	0.255	0.300	0.085	0.096	0.306	0.258	0.337	0.308	554
11H-I:	0.328	0.301	0.300	0.327	0.302	0.225	0.257	0.280	0.370	0.314	320
BT/MM:	0.467	0.459	0.365	0.428	0.244	0.243	0.426	0.424	0.489	0.461	837
OS:	0.604	0.732	0.591	0.669	0.485	0.517	0.382	0.719	0.618	0.521	622
RM:	0.634	0.682	0.600	0.603	0.404	0.419	0.328	0.592	0.566	0.499	250
13F:	0.597	0.705	0.587	0.671	0.426	0.465	0.481	0.632	0.649	0.541	819
19K:	0.195	0.194	0.138	0.179	0.182	0.168	0.129	0.209	0.182	0.136	1106
272-1:	0.586	0.671	0.650	0.665	0.345	0.329	0.457	0.559	0.612	0.555	484
732:	0.682	0.784	0.668	0.731	0.467	0.426	0.431	0.715	0.620	0.539	421

Appendix D

Time Limits and Estimated Population Mean Completion Times for Relevant ASVAB and ECAT Subtests

Table D-1

Time Limits (paper & pencil testing) and Estimated Population Mean Completion Times (computerized testing) for relevant ASVAB and ECAT[1] Subtests[2]

Subtest:	Testing Method: Paper and Pencil:	Computerized:
ASVAB		
GS:	11.000	4.712
AR:	36.000	20.973
WK:	11.000	4.112
PC:	13.000	13.604
NO:	3.000	3.000
CS:	7.000	7.000
AS:	11.000	6.196
MK:	24.000	9.461
MC:	19.000	10.787
EI:	9.000	4.419
ECAT		
CT:		9.894
SM:		16.274
FR:	13.398	9.434
ID:		14.430
AO:	16.231	9.778
SO:	8.593	5.657
T1:		3.762
T2:		3.764
TI:		2.692

1. Only the FR, AO, and SO ECAT subtests can be admministered in paper and pencil form.
2. Times are in minutes.

Appendix E
Initial Matrix Derivation

The following steps illustrate how the matrices in each contrast were generated from our Population #2 Matrix and school validity matrices. For simplicity we consider only four tests that are reduced in length by 20%, and four schools.

We start out with:

(1) Original Test Intercorrelations:

		1 GS	2 AR	3 WK	4 PC
1	GS	1.000	.611	.720	.608
2	AR		1.000	.596	.574
3	WK			1.000	.732
4	PC				1.000

(2) Original Validities:

		1 GS	2 AR	3 WK	4 PC
1	AC	.614	.711	.513	.561
2	AE	.565	.559	.526	.451
3	AMS	.682	.648	.671	.579
4	AO	.516	.555	.474	.478

(3) Original Reliabilities:

1 GS	2 AR	3 WK	4 PC
.86	.91	.92	.81

(4) The Reliabilities for length n = .8, shown below, were generated from Spearman-Brown:

$$r_{nn} = \frac{nr_{11}}{1+(n-1)(r_{11})}$$

Thus, e.g., for GS:

$$r_{.8,.8} = \frac{.8(.86)}{1-(.2)(.86)} = .831$$

Reliabilities for Length n = .8:

1	2	3	4
GS	AR	WK	PC
.831	.890	.902	.773

In order to calculate the intercorrelations and validities for tests of altered length, the following formulae apply.

Let X(T), Y(T) be "true scores" on tests X and Y; X(1), Y(1) be scores on tests X and Y of unit (or original) length, and X(n), Y(n) be scores on tests X and Y or altered length, n.

From the correction for attenuation, we know:

$$r_{X(T),Y(T)} = \frac{r_{X(1),Y(1)}}{\sqrt{r_{X(1),X(1)}\ r_{Y(1),Y(1)}}} \qquad [1]$$

Similarly:

$$r_{X(T),Y(T)} = \frac{r_{X(n),Y(n)}}{\sqrt{r_{X(n),X(n)}\ r_{Y(n),Y(n)}}} \qquad [2]$$

From [1] and [2]:

$$r_{X(n),Y(n)} = r_{X(1),Y(1)} \left(\sqrt{\frac{r_{X(n),X(n)}}{r_{X(1),X(1)}}}\right) \left(\sqrt{\frac{r_{Y(n),Y(n)}}{r_{Y(1),Y(1)}}}\right) \qquad [3]$$

or:

$$r_{X(n),\ Y(n)} = r_{X(1),\ Y(1)}\ W_X\ W_Y \qquad [4]$$

where the weights are the square root of the ratios of the two reliabilities for the test in question.

Similarly, for validities, where only X is modified in length, we have:

$$r_{X(n),\ Y(1)} = r_{X(1),\ Y(1)}\ W_X. \qquad [5]$$

(5) The weights were generated from the original and n =.8 reliabilities. e.g.:

$$w_1 = \sqrt{\frac{.831}{86}} = .983$$

Weights:

W1	W2	W3	W4
.983	.989	.990	.977

(6) The intercorrelations for n = .8 were generated, e.g., $r_{1(n),\,2(n)} = r_{1(1),\,2(1)}\ W_1\ W_2 = (.611)(.983)(.989) = .594$

Test Intercorrelations for n = .8:

		1 GS	2 AR	3 WK	4 PC
1	GS	1.000	.594	.701	.584
2	AR		1.000	.584	.555
3	WK			1.000	.708
4	PC				1.000

(7) The validities were generated, e.g. $r_{1(n),A(1)} = r_{1(1),A(1)}\ W_1 = (.614)(.983) = .604$

Validities for n = .8:

		1 GS	2 AR	3 WK	4 PC
1	AC	.604	.703	.508	.548
2	AE	.555	.553	.521	.441
3	AMS	.670	.641	.664	.566
4	AO	.507	.549	.469	.467

Appendix F
Optional Test Length Intercorrelations and Validities for Each Testing Condition

Table F-1

ASVAB Z-Score intercorrelations (Mean = 0, SD = 1) for Optimal Test Lengths and 100 Minutes Testing Time

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	MEAN:	SD:
GS:	0.551	0.708	0.483	0.270	0.244	0.496	0.525	0.587	0.651	0.000	1.000
AR:		0.547	0.426	0.432	0.363	0.356	0.625	0.527	0.474	0.000	1.000
WK:			0.592	0.324	0.328	0.423	0.478	0.513	0.567	0.000	1.000
PC:				0.320	0.312	0.266	0.389	0.368	0.381	0.000	1.000
NO:					0.640	0.045	0.478	0.213	0.154	0.000	1.000
CS:						0.056	0.393	0.207	0.156	0.000	1.000
AS:							0.183	0.561	0.688	0.000	1.000
MK:								0.445	0.377	0.000	1.000
MC:									0.626	0.000	1.000
EI:										0.000	1.000

Test:	Time (minutes):	Reliability:
GS:	9	.81
AR:	16	.72
WK:	11	.88
PC:	5	.44
NO:	3	.86
CS:	7	.82
AS:	8	.78
MK:	15	.81
MC:	12	.67
EI:	14	.78
TOTAL:	100	

Table F-2

ASVAB Validities, Corrected for Criterion Unreliability and Range Restriction, together with Sample Sizes, in Eighteen Joint Service Schools, with Optimal Test Lengths and 100 Minutes Testing Time

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.619	0.669	0.527	0.466	0.460	0.502	0.335	0.751	0.469	0.539	72
AE:	0.576	0.532	0.545	0.378	0.318	0.356	0.436	0.544	0.512	0.569	173
AMS:	0.695	0.617	0.696	0.486	0.404	0.434	0.515	0.593	0.611	0.637	244
AO:	0.537	0.540	0.503	0.410	0.405	0.410	0.347	0.595	0.436	0.492	233
AV:	0.600	0.673	0.607	0.468	0.398	0.372	0.408	0.659	0.492	0.630	197
EM:	0.529	0.567	0.488	0.366	0.360	0.350	0.341	0.562	0.485	0.500	805
EN:	0.616	0.580	0.579	0.441	0.326	0.303	0.558	0.531	0.593	0.652	781
FC:	0.600	0.629	0.594	0.477	0.405	0.387	0.447	0.633	0.587	0.621	727
GMG:	0.555	0.623	0.598	0.433	0.367	0.332	0.436	0.591	0.528	0.553	393
11H-H:	0.243	0.218	0.251	0.216	0.085	0.096	0.282	0.240	0.296	0.300	554
11H-I:	0.315	0.266	0.295	0.236	0.302	0.225	0.237	0.260	0.325	0.307	320
BT/MM:	0.448	0.404	0.359	0.309	0.244	0.243	0.393	0.395	0.429	0.449	837
OS:	0.580	0.644	0.582	0.483	0.485	0.517	0.352	0.669	0.543	0.509	622
RM:	0.609	0.601	0.591	0.435	0.404	0.419	0.302	0.551	0.496	0.487	250
13F:	0.573	0.621	0.578	0.484	0.426	0.465	0.443	0.588	0.569	0.528	819
19K:	0.187	0.171	0.135	0.129	0.182	0.168	0.119	0.194	0.160	0.133	1106
272-1:	0.562	0.591	0.640	0.480	0.345	0.329	0.422	0.520	0.537	0.542	484
732:	0.655	0.691	0.658	0.528	0.467	0.426	0.397	0.664	0.544	0.526	421

Table F-3

ASVAB Z-Score Intercorrelations (Mean = 0, SD = 1) for Optimal Test Lengths and 180 Minutes Testing Time

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	MEAN:	SD:
GS:	0.610	0.753	0.667	0.290	0.262	0.541	0.561	0.676	0.719	0.000	1.000
AR:		0.591	0.597	0.471	0.395	0.395	0.679	0.617	0.531	0.000	1.000
WK:			0.798	0.340	0.344	0.451	0.500	0.577	0.611	0.000	1.000
PC:				0.436	0.424	0.367	0.528	0.537	0.534	0.000	1.000
NO:					0.677	0.049	0.504	0.242	0.168	0.000	1.000
CS:						0.061	0.414	0.235	0.170	0.000	1.000
AS:							0.197	0.648	0.761	0.000	1.000
MK:								0.504	0.410	0.000	1.000
MC:									0.732	0.000	1.000
EI:										0.000	1.000

Test:	Time (minutes):	Reliability:
GS:	16	.88
AR:	26	.80
WK:	16	.91
PC:	21	.77
NO:	5	.91
CS:	10	.87
AS:	13	.85
MK:	20	.85
MC:	26	.81
EI:	27	.87
TOTAL:	180	

Table F-4

ASVAB Validities, Corrected for Criterion Unreliability and Range Restriction, together with Sample Sizes, in Eighteen Joint Service Schools, with Optimal Test Lengths and 180 Minutes Testing Time

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.646	0.709	0.537	0.616	0.473	0.516	0.350	0.770	0.517	0.571	72
AE:	0.601	0.563	0.555	0.500	0.328	0.366	0.456	0.557	0.566	0.602	173
AMS:	0.726	0.654	0.709	0.643	0.416	0.446	0.538	0.608	0.674	0.674	244
AO:	0.561	0.572	0.513	0.542	0.417	0.422	0.363	0.610	0.481	0.521	233
AV:	0.627	0.713	0.619	0.618	0.410	0.382	0.426	0.676	0.544	0.667	197
EM:	0.552	0.601	0.497	0.483	0.371	0.360	0.357	0.576	0.536	0.529	805
EN:	0.643	0.615	0.590	0.583	0.336	0.312	0.583	0.545	0.655	0.690	781
FC:	0.626	0.667	0.605	0.630	0.417	0.398	0.467	0.649	0.648	0.658	727
GMG:	0.579	0.660	0.609	0.572	0.378	0.341	0.456	0.606	0.583	0.585	393
11H-H:	0.254	0.231	0.256	0.286	0.088	0.099	0.295	0.246	0.327	0.318	554
11H-I:	0.329	0.281	0.301	0.312	0.310	0.231	0.248	0.267	0.359	0.325	320
BT/MM:	0.467	0.428	0.366	0.408	0.251	0.250	0.411	0.405	0.474	0.476	837
OS:	0.605	0.683	0.593	0.638	0.499	0.531	0.368	0.686	0.599	0.539	622
RM:	0.635	0.637	0.602	0.575	0.415	0.431	0.316	0.565	0.548	0.516	250
13F:	0.598	0.658	0.589	0.640	0.438	0.478	0.463	0.602	0.628	0.559	819
19K:	0.196	0.181	0.138	0.171	0.187	0.173	0.124	0.199	0.177	0.141	1106
272-1:	0.587	0.626	0.653	0.634	0.355	0.338	0.441	0.533	0.593	0.573	484
732:	0.684	0.732	0.671	0.698	0.480	0.438	0.415	0.681	0.601	0.557	421

Table F-5

Testing Condition A_1: B_1 (1.66)

DATA FILE: PP-100P.DAT
P&P 100 MINUTE OPTIMAL TEST LENGTH INTERCORRELATIONS

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	MEAN:	SD:
GS:	0.551	0.708	0.483	0.270	0.244	0.496	0.525	0.587	0.651	0.000	1.000
AR:		0.547	0.426	0.432	0.363	0.356	0.625	0.527	0.474	0.000	1.000
WK:			0.592	0.324	0.328	0.423	0.478	0.513	0.567	0.000	1.000
PC:				0.320	0.312	0.266	0.389	0.368	0.381	0.000	1.000
NO:					0.640	0.045	0.478	0.213	0.154	0.000	1.000
CS:						0.056	0.393	0.207	0.156	0.000	1.000
AS:							0.183	0.561	0.688	0.000	1.000
MK:								0.445	0.377	0.000	1.000
MC:									0.626	0.000	1.000
EI:										0.000	1.000

Table F-6

Testing Condition A_1: B_1 (1.66)

DATA FILE: PP-100C.DAT
P&P 100 MINUTE OPTIMAL TEST LENGTH VALIDITIES

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.619	0.669	0.527	0.466	0.460	0.502	0.335	0.751	0.469	0.539	72
AE:	0.576	0.532	0.545	0.378	0.318	0.356	0.436	0.544	0.512	0.569	173
AMS:	0.695	0.617	0.696	0.486	0.404	0.434	0.515	0.593	0.611	0.637	244
AO:	0.537	0.540	0.503	0.410	0.405	0.410	0.347	0.595	0.436	0.492	233
AV:	0.600	0.673	0.607	0.468	0.398	0.372	0.408	0.659	0.492	0.630	197
EM:	0.529	0.567	0.488	0.366	0.360	0.350	0.341	0.562	0.485	0.500	805
EN:	0.616	0.580	0.579	0.441	0.326	0.303	0.558	0.531	0.593	0.652	781
FC:	0.600	0.629	0.594	0.477	0.405	0.387	0.447	0.633	0.587	0.621	727
GMG:	0.555	0.623	0.598	0.433	0.367	0.332	0.436	0.591	0.528	0.553	393
11H-H:	0.243	0.218	0.251	0.216	0.085	0.096	0.282	0.240	0.296	0.300	554
11H-I:	0.315	0.266	0.295	0.236	0.302	0.225	0.237	0.260	0.325	0.307	320
BT/MM:	0.448	0.404	0.359	0.309	0.244	0.243	0.393	0.395	0.429	0.449	837
OS:	0.580	0.644	0.582	0.483	0.485	0.517	0.352	0.669	0.543	0.509	622
RM:	0.609	0.601	0.591	0.435	0.404	0.419	0.302	0.551	0.496	0.487	250
13F:	0.573	0.621	0.578	0.484	0.426	0.465	0.443	0.588	0.569	0.528	819
19K:	0.187	0.171	0.135	0.129	0.182	0.168	0.119	0.194	0.160	0.133	1106
272-1:	0.562	0.591	0.640	0.480	0.345	0.329	0.422	0.520	0.537	0.542	484
732:	0.655	0.691	0.658	0.528	0.467	0.426	0.397	0.664	0.544	0.526	421

Table F-7

Testing Condition A_2: B_2 (1.66)

DATA FILE: B2-100P2.DAT
CAT-ASVAB FINAL HORST 100 MIN INTERCORRELATIONS

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	MEAN:	SD:
GS:	0.654	0.793	0.734	0.291	0.264	0.577	0.600	0.733	0.767	0.000	1.000
AR:		0.633	0.668	0.479	0.404	0.428	0.737	0.679	0.576	0.000	1.000
WK:			0.877	0.340	0.345	0.481	0.533	0.624	0.651	0.000	1.000
PC:				0.455	0.445	0.409	0.588	0.606	0.594	0.000	1.000
NO:					0.646	0.050	0.511	0.249	0.170	0.000	1.000
CS:						0.062	0.422	0.243	0.173	0.000	1.000
AS:							0.212	0.710	0.822	0.000	1.000
MK:								0.553	0.442	0.000	1.000
MC:									0.801	0.000	1.000
EI:										0.000	1.000

Table F-8

Testing Condition A_2: B_2 (1.66)

DATA FILE: B2-100C2.DAT
CAT-ASVAB FINAL HORST 100 MIN VALIDITIES

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.664	0.741	0.551	0.660	0.461	0.505	0.363	0.801	0.545	0.593	72
AE:	0.618	0.588	0.570	0.536	0.319	0.359	0.473	0.579	0.596	0.625	173
AMS:	0.745	0.683	0.727	0.689	0.405	0.437	0.559	0.632	0.711	0.700	244
AO:	0.576	0.597	0.526	0.581	0.406	0.413	0.377	0.634	0.508	0.541	233
AV:	0.644	0.745	0.635	0.663	0.399	0.374	0.443	0.703	0.573	0.692	197
EM:	0.567	0.627	0.510	0.518	0.361	0.352	0.371	0.599	0.565	0.549	805
EN:	0.661	0.642	0.605	0.625	0.327	0.305	0.606	0.566	0.691	0.717	781
FC:	0.643	0.697	0.621	0.675	0.406	0.390	0.486	0.675	0.683	0.683	727
GMG:	0.595	0.689	0.625	0.613	0.368	0.334	0.474	0.630	0.615	0.608	393
11H-H:	0.261	0.242	0.262	0.307	0.085	0.097	0.306	0.256	0.345	0.330	554
11H-I:	0.338	0.294	0.309	0.334	0.302	0.227	0.257	0.277	0.378	0.337	320
BT/MM:	0.480	0.448	0.375	0.437	0.244	0.245	0.427	0.421	0.499	0.494	837
OS:	0.621	0.713	0.608	0.684	0.486	0.520	0.383	0.713	0.632	0.559	622
RM:	0.653	0.665	0.618	0.616	0.405	0.422	0.328	0.587	0.578	0.536	250
13F:	0.614	0.688	0.604	0.685	0.427	0.468	0.481	0.627	0.663	0.580	819
19K:	0.201	0.189	0.142	0.183	0.182	0.170	0.129	0.207	0.186	0.146	1106
272-1:	0.603	0.654	0.669	0.679	0.346	0.331	0.458	0.554	0.625	0.595	484
732:	0.702	0.765	0.688	0.748	0.468	0.429	0.431	0.708	0.633	0.578	421

Table F-9

Testing Condition A_3: B_3 (2.25)

DATA FILE: B3-135P1.DAT
P&P ASVAB + ECAT FINAL HORST 135 MIN INTERCORRELATIONS

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:
GS:	0.566	0.723	0.555	0.279	0.251	0.513	0.537	0.612	0.677
AR:		0.554	0.485	0.442	0.370	0.366	0.634	0.545	0.488
WK:			0.669	0.330	0.332	0.432	0.483	0.527	0.580
PC:				0.366	0.355	0.305	0.441	0.425	0.439
NO:					0.656	0.047	0.488	0.222	0.160
CS:						0.058	0.399	0.214	0.161
AS:							0.188	0.585	0.714
MK:								0.459	0.388
MC:									0.655
EI:									

	FR:	AO:	SO:	MEAN:	SD:
GS:	0.464	0.360	0.481	0.000	1.000
AR:	0.512	0.361	0.490	0.000	1.000
WK:	0.441	0.304	0.434	0.000	1.000
PC:	0.374	0.248	0.352	0.000	1.000
NO:	0.290	0.183	0.225	0.000	1.000
CS:	0.270	0.203	0.238	0.000	1.000
AS:	0.283	0.292	0.380	0.000	1.000
MK:	0.490	0.343	0.460	0.000	1.000
MC:	0.473	0.407	0.529	0.000	1.000
EI:	0.388	0.351	0.458	0.000	1.000
FR:		0.408	0.498	0.000	1.000
AO:			0.437	0.000	1.000
SO:				0.000	1.000

Table F-10

Testing Condition A_3: B_3 (2.25)

DATA FILE: B3-135C1.DAT
P&P ASVAB + ECAT FINAL HORST 135 MIN VALIDITIES

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.631	0.676	0.528	0.525	0.466	0.507	0.340	0.756	0.480	0.551	72
AE:	0.587	0.537	0.547	0.426	0.323	0.360	0.443	0.547	0.525	0.581	173
AMS:	0.708	0.623	0.698	0.548	0.410	0.438	0.523	0.597	0.626	0.650	244
AO:	0.547	0.545	0.504	0.462	0.411	0.414	0.353	0.598	0.447	0.502	233
AV:	0.611	0.680	0.609	0.527	0.404	0.375	0.415	0.663	0.504	0.643	197
EM:	0.538	0.572	0.489	0.412	0.365	0.353	0.347	0.565	0.497	0.510	805
EN:	0.627	0.586	0.580	0.497	0.331	0.306	0.568	0.534	0.608	0.666	781
FC:	0.611	0.635	0.595	0.537	0.411	0.391	0.454	0.637	0.601	0.635	727
GMG:	0.565	0.629	0.599	0.488	0.373	0.335	0.443	0.594	0.541	0.565	393
11H-H:	0.248	0.220	0.252	0.244	0.087	0.097	0.287	0.241	0.304	0.307	554
11H-I:	0.321	0.268	0.296	0.266	0.306	0.227	0.241	0.261	0.333	0.313	320
BT/MM:	0.456	0.408	0.360	0.348	0.247	0.245	0.400	0.397	0.440	0.459	837
OS:	0.590	0.651	0.584	0.544	0.492	0.522	0.358	0.673	0.556	0.519	622
RM:	0.620	0.607	0.593	0.490	0.409	0.423	0.307	0.554	0.509	0.497	250
13F:	0.584	0.627	0.580	0.545	0.432	0.470	0.451	0.591	0.583	0.539	819
19K:	0.191	0.173	0.136	0.146	0.184	0.170	0.121	0.195	0.164	0.136	1106
272-1:	0.573	0.597	0.642	0.540	0.350	0.332	0.429	0.522	0.550	0.553	484
732:	0.667	0.698	0.660	0.595	0.474	0.430	0.404	0.668	0.558	0.537	421

	FR:	AO:	SO:	N;
AC:	0.545	0.404	0.474	72
AE:	0.469	0.411	0.508	173
AMS:	0.482	0.383	0.486	244
AO:	0.439	0.367	0.440	233
AV:	0.496	0.385	0.472	197
EM:	0.437	0.316	0.432	805
EN:	0.455	0.365	0.494	781
FC:	0.518	0.399	0.523	727
GMG:	0.493	0.356	0.484	393
11H-H:	0.205	0.228	0.298	554
11H-I:	0.203	0.220	0.320	320
BT/MM:	0.383	0.320	0.321	837
OS:	0.525	0.388	0.517	622
RM:	0.440	0.344	0.466	250
13F:	0.547	0.434	0.563	819
19K:	0.105	0.130	0.134	1106
272-1:	0.462	0.377	0.530	484
732:	0.566	0.378	0.544	421

Table F-11

Testing Condition A_4: B_4 (2.25)

DATA FILE: B4-135P3.DAT
CAT-ASVAB+NON-PEDESTAL ECAT FOURTH HORST 135 MIN INTERCORRELATIONS

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:
GS:	0.658	0.797	0.749	0.294	0.259	0.584	0.603	0.741	0.774
AR:		0.634	0.680	0.483	0.396	0.432	0.740	0.685	0.580
WK:			0.891	0.342	0.337	0.484	0.534	0.629	0.654
PC:				0.465	0.442	0.419	0.599	0.621	0.606
NO:					0.636	0.050	0.515	0.253	0.172
CS:						0.061	0.413	0.239	0.169
AS:							0.214	0.720	0.831
MK:								0.558	0.445
MC:									0.811
EI:									

	CT:	SM:	FR:	ID:	AO:	SO:	MEAN:	SD:
GS:	0.349	0.329	0.492	0.229	0.413	0.494	0.000	1.000
AR:	0.505	0.459	0.563	0.249	0.430	0.523	0.000	1.000
WK:	0.319	0.328	0.461	0.193	0.344	0.439	0.000	1.000
PC:	0.363	0.368	0.479	0.194	0.344	0.437	0.000	1.000
NO:	0.333	0.299	0.290	0.111	0.197	0.218	0.000	1.000
CS:	0.305	0.288	0.264	0.108	0.215	0.225	0.000	1.000
AS:	0.195	0.152	0.306	0.173	0.341	0.398	0.000	1.000
MK:	0.473	0.428	0.521	0.228	0.396	0.475	0.000	1.000
MC:	0.418	0.356	0.543	0.271	0.506	0.588	0.000	1.000
EI:	0.281	0.238	0.420	0.216	0.412	0.482	0.000	1.000
CT:		0.472	0.464	0.212	0.422	0.431	0.000	1.000
SM:			0.429	0.181	0.345	0.372	0.000	1.000
FR:				0.239	0.444	0.485	0.000	1.000
ID:					0.231	0.237	0.000	1.000
AO:						0.461	0.000	1.000
SO:							0.000	1.000

Table F-12

Testing Condition A_4: B_4 (2.25)

DATA FILE: B4-135C3.DAT
CAT-ASVAB+NON-PEDESTAL ECAT FOURTH HORST 135 MIN VALIDITIES

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.667	0.742	0.551	0.671	0.464	0.494	0.366	0.803	0.550	0.595	72
AE:	0.620	0.589	0.570	0.544	0.321	0.350	0.477	0.581	0.601	0.628	173
AMS:	0.748	0.684	0.727	0.700	0.408	0.427	0.563	0.634	0.716	0.703	244
AO:	0.578	0.598	0.526	0.590	0.409	0.404	0.380	0.636	0.512	0.543	233
AV:	0.646	0.746	0.635	0.673	0.402	0.366	0.446	0.704	0.578	0.695	197
EM:	0.569	0.628	0.510	0.526	0.364	0.344	0.373	0.601	0.569	0.552	805
EN:	0.663	0.643	0.605	0.635	0.329	0.298	0.611	0.568	0.696	0.720	781
FC:	0.646	0.698	0.621	0.686	0.409	0.381	0.489	0.676	0.688	0.686	727
GMG:	0.597	0.690	0.625	0.623	0.371	0.327	0.477	0.631	0.620	0.610	393
11H-H:	0.262	0.242	0.262	0.312	0.086	0.094	0.309	0.256	0.347	0.332	554
11H-I:	0.339	0.294	0.309	0.339	0.304	0.221	0.259	0.278	0.381	0.339	320
BT/MM:	0.482	0.448	0.375	0.444	0.246	0.239	0.430	0.422	0.503	0.496	837
OS:	0.624	0.714	0.608	0.695	0.490	0.508	0.386	0.715	0.636	0.562	622
RM:	0.655	0.666	0.618	0.626	0.407	0.413	0.331	0.589	0.582	0.538	250
13F:	0.617	0.689	0.604	0.697	0.430	0.457	0.485	0.628	0.668	0.583	819
19K:	0.202	0.190	0.142	0.186	0.183	0.166	0.130	0.207	0.188	0.147	1106
272-1:	0.605	0.655	0.669	0.690	0.348	0.324	0.461	0.555	0.630	0.598	484
732:	0.705	0.766	0.688	0.760	0.471	0.419	0.435	0.710	0.638	0.580	421

	CT:	SM:	FR:	ID:	AO:	SO:	N;
AC:	0.481	0.423	0.547	0.207	0.438	0.461	72
AE:	0.458	0.396	0.470	0.246	0.446	0.493	173
AMS:	0.375	0.358	0.483	0.234	0.415	0.472	244
AO:	0.367	0.293	0.440	0.201	0.398	0.427	233
AV:	0.463	0.408	0.498	0.232	0.418	0.459	197
EM:	0.399	0.315	0.438	0.200	0.343	0.420	805
EN:	0.365	0.296	0.456	0.219	0.396	0.480	781
FC:	0.407	0.362	0.519	0.238	0.433	0.508	727
GMG:	0.441	0.340	0.495	0.215	0.386	0.470	393
11H-H:	0.207	0.171	0.205	0.109	0.247	0.289	554
11H-I:	0.236	0.262	0.203	0.135	0.239	0.310	320
BT/MM:	0.283	0.235	0.384	0.167	0.348	0.312	837
OS:	0.502	0.432	0.527	0.233	0.421	0.502	622
RM:	0.439	0.410	0.441	0.221	0.373	0.453	250
13F:	0.482	0.440	0.549	0.255	0.471	0.547	819
19K:	0.141	0.131	0.105	0.068	0.141	0.130	1106
272-1:	0.456	0.384	0.463	0.211	0.409	0.515	484
732:	0.453	0.463	0.568	0.238	0.410	0.528	421

Table F-13

Testing Condition A_5: B_1 (3.00)

DATA FILE: PP-180P.DAT
P&P 180 MINUTE OPTIMAL TEST LENGTH INTERCORRELATIONS

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	MEAN:	SD:
GS:	0.610	0.753	0.667	0.290	0.262	0.541	0.561	0.676	0.719	0.000	1.000
AR:		0.591	0.597	0.471	0.395	0.395	0.679	0.617	0.531	0.000	1.000
WK:			0.798	0.340	0.344	0.451	0.500	0.577	0.611	0.000	1.000
PC:				0.436	0.424	0.367	0.528	0.537	0.534	0.000	1.000
NO:					0.677	0.049	0.504	0.242	0.168	0.000	1.000
CS:						0.061	0.414	0.235	0.170	0.000	1.000
AS:							0.197	0.648	0.761	0.000	1.000
MK:								0.504	0.410	0.000	1.000
MC:									0.732	0.000	1.000
EI:										0.000	1.000

Table F-14

Testing Condition A_5: B_1 (3.00)

DATA FILE: PP-180C.DAT
P&P 180 MINUTE OPTIMAL TEST LENGTH VALIDITIES

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.646	0.709	0.537	0.616	0.473	0.516	0.350	0.770	0.517	0.571	72
AE:	0.601	0.563	0.555	0.500	0.328	0.366	0.456	0.557	0.566	0.602	173
AMS:	0.726	0.654	0.709	0.643	0.416	0.446	0.538	0.608	0.674	0.674	244
AO:	0.561	0.572	0.513	0.542	0.417	0.422	0.363	0.610	0.481	0.521	233
AV:	0.627	0.713	0.619	0.618	0.410	0.382	0.426	0.676	0.544	0.667	197
EM:	0.552	0.601	0.497	0.483	0.371	0.360	0.357	0.576	0.536	0.529	805
EN:	0.643	0.615	0.590	0.583	0.336	0.312	0.583	0.545	0.655	0.690	781
FC:	0.626	0.667	0.605	0.630	0.417	0.398	0.467	0.649	0.648	0.658	727
GMG:	0.579	0.660	0.609	0.572	0.378	0.341	0.456	0.606	0.583	0.585	393
11H-H:	0.254	0.231	0.256	0.286	0.088	0.099	0.295	0.246	0.327	0.318	554
11H-I:	0.329	0.281	0.301	0.312	0.310	0.231	0.248	0.267	0.359	0.325	320
BT/MM:	0.467	0.428	0.366	0.408	0.251	0.250	0.411	0.405	0.474	0.476	837
OS:	0.605	0.683	0.593	0.638	0.499	0.531	0.368	0.686	0.599	0.539	622
RM:	0.635	0.637	0.602	0.575	0.415	0.431	0.316	0.565	0.548	0.516	250
13F:	0.598	0.658	0.589	0.640	0.438	0.478	0.463	0.602	0.628	0.559	819
19K:	0.196	0.181	0.138	0.171	0.187	0.173	0.124	0.199	0.177	0.141	1106
272-1:	0.587	0.626	0.653	0.634	0.355	0.338	0.441	0.533	0.593	0.573	484
732:	0.684	0.732	0.671	0.698	0.480	0.438	0.415	0.681	0.601	0.557	421

Table F-15

Testing Condition A_6: B_3 (3.00)

DATA FILE: B3-180P1.DAT
P&P ASVAB + ECAT FINAL HORST 180 MIN INTERCORRELATIONS

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:
GS:	0.595	0.745	0.642	0.287	0.259	0.532	0.554	0.659	0.708
AR:		0.578	0.569	0.461	0.386	0.384	0.663	0.594	0.517
WK:			0.770	0.337	0.340	0.445	0.495	0.563	0.603
PC:				0.421	0.409	0.353	0.508	0.510	0.513
NO:					0.671	0.048	0.499	0.237	0.165
CS:						0.060	0.409	0.229	0.167
AS:							0.194	0.629	0.748
MK:								0.491	0.403
MC:									0.711
EI:									

	FR:	AO:	SO:	MEAN:	SD:
GS:	0.487	0.399	0.499	0.000	1.000
AR:	0.544	0.405	0.516	0.000	1.000
WK:	0.460	0.335	0.447	0.000	1.000
PC:	0.438	0.307	0.408	0.000	1.000
NO:	0.302	0.201	0.232	0.000	1.000
CS:	0.282	0.224	0.245	0.000	1.000
AS:	0.297	0.324	0.395	0.000	1.000
MK:	0.511	0.378	0.475	0.000	1.000
MC:	0.515	0.469	0.569	0.000	1.000
EI:	0.410	0.393	0.480	0.000	1.000
FR:		0.457	0.523	0.000	1.000
AO:			0.485	0.000	1.000
SO:				0.000	1.000

Table F-16

Testing Condition A_6: B_3 (3.00)

DATA FILE: B3-180C1.DAT
P&P + ECAT FINAL HORST 180 MIN VALIDITIES

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.642	0.697	0.534	0.597	0.471	0.513	0.347	0.765	0.507	0.566	72
AE:	0.597	0.554	0.553	0.485	0.326	0.364	0.452	0.554	0.555	0.597	173
AMS:	0.721	0.642	0.706	0.623	0.414	0.444	0.533	0.604	0.661	0.668	244
AO:	0.557	0.562	0.510	0.526	0.415	0.419	0.359	0.606	0.472	0.516	233
AV:	0.623	0.701	0.617	0.600	0.408	0.380	0.422	0.671	0.533	0.660	197
EM:	0.548	0.590	0.495	0.469	0.369	0.358	0.354	0.573	0.525	0.524	805
EN:	0.639	0.604	0.587	0.565	0.334	0.310	0.578	0.541	0.643	0.684	781
FC:	0.622	0.655	0.603	0.611	0.416	0.396	0.463	0.645	0.635	0.652	727
GMG:	0.575	0.648	0.607	0.555	0.376	0.339	0.452	0.602	0.572	0.580	393
11H-H:	0.252	0.227	0.255	0.277	0.087	0.098	0.292	0.244	0.321	0.315	554
11H-I:	0.327	0.277	0.300	0.302	0.309	0.230	0.246	0.265	0.352	0.322	320
BT/MM:	0.464	0.421	0.364	0.396	0.250	0.248	0.407	0.402	0.464	0.471	837
OS:	0.601	0.671	0.591	0.619	0.497	0.528	0.365	0.681	0.587	0.534	622
RM:	0.631	0.626	0.600	0.557	0.414	0.429	0.313	0.561	0.537	0.511	250
13F:	0.594	0.647	0.587	0.620	0.436	0.475	0.459	0.599	0.616	0.553	819
19K:	0.194	0.178	0.138	0.166	0.186	0.172	0.123	0.198	0.173	0.139	1106
272-1:	0.583	0.616	0.650	0.615	0.354	0.336	0.437	0.529	0.581	0.568	484
732:	0.679	0.719	0.668	0.676	0.478	0.436	0.412	0.677	0.589	0.551	421

	FR:	AO:	SO:	N;
AC:	0.562	0.439	0.483	72
AE:	0.483	0.448	0.518	173
AMS:	0.496	0.417	0.496	244
AO:	0.452	0.399	0.448	233
AV:	0.512	0.419	0.481	197
EM:	0.450	0.344	0.440	805
EN:	0.469	0.397	0.504	781
FC:	0.533	0.434	0.533	727
GMG:	0.508	0.387	0.493	393
11H-H:	0.211	0.248	0.304	554
11H-I:	0.209	0.240	0.326	320
BT/MM:	0.395	0.349	0.328	837
OS:	0.541	0.422	0.527	622
RM:	0.453	0.374	0.475	250
13F:	0.564	0.472	0.574	819
19K:	0.108	0.141	0.136	1106
272-1:	0.476	0.410	0.540	484
732:	0.583	0.411	0.554	421

Table F-17

Testing Condition A_7: B_4 (3.00)

DATA FILE: B4-180P1.DAT
CAT-ASVAB + NON-PEDESTAL ECAT SECOND HORST 180 MIN INTERCORRELATIONS

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:
GS:	0.668	0.806	0.764	0.300	0.268	0.590	0.609	0.756	0.783
AR:		0.646	0.698	0.497	0.412	0.440	0.752	0.704	0.590
WK:			0.911	0.351	0.350	0.491	0.541	0.643	0.663
PC:				0.481	0.462	0.428	0.611	0.640	0.619
NO:					0.666	0.051	0.527	0.261	0.176
CS:						0.063	0.427	0.250	0.175
AS:							0.217	0.736	0.842
MK:								0.570	0.451
MC:									0.829
EI:									

	CT:	SM:	FR:	ID:	AO:	SO:	MEAN:	SD:
GS:	0.369	0.358	0.525	0.375	0.458	0.518	0.000	1.000
AR:	0.539	0.504	0.605	0.411	0.480	0.553	0.000	1.000
WK:	0.338	0.358	0.493	0.318	0.382	0.462	0.000	1.000
PC:	0.388	0.405	0.516	0.321	0.385	0.463	0.000	1.000
NO:	0.358	0.330	0.313	0.184	0.221	0.232	0.000	1.000
CS:	0.331	0.322	0.289	0.181	0.244	0.242	0.000	1.000
AS:	0.207	0.166	0.326	0.284	0.379	0.418	0.000	1.000
MK:	0.502	0.467	0.556	0.374	0.439	0.498	0.000	1.000
MC:	0.448	0.392	0.586	0.449	0.567	0.623	0.000	1.000
EI:	0.298	0.259	0.449	0.354	0.458	0.506	0.000	1.000
CT:		0.539	0.520	0.364	0.491	0.474	0.000	1.000
SM:			0.493	0.321	0.413	0.421	0.000	1.000
FR:				0.413	0.520	0.538	0.000	1.000
ID:					0.416	0.404	0.000	1.000
AO:						0.530	0.000	1.000
SO:							0.000	1.000

Table F-18

Testing Condition A_7: B_4 (3.00)

DATA FILE: B4-180C1.DAT
CAT-ASVAB + NON-PEDESTAL ECAT SECOND HORST 180 MIN VALIDITIES

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.670	0.751	0.554	0.681	0.472	0.508	0.368	0.807	0.558	0.599	72
AE:	0.623	0.596	0.574	0.553	0.327	0.361	0.480	0.584	0.610	0.632	173
AMS:	0.752	0.692	0.732	0.710	0.415	0.439	0.566	0.637	0.727	0.708	244
AO:	0.581	0.605	0.530	0.599	0.416	0.415	0.382	0.639	0.519	0.547	233
AV:	0.650	0.755	0.640	0.684	0.409	0.377	0.449	0.708	0.586	0.700	197
EM:	0.572	0.636	0.514	0.534	0.370	0.354	0.376	0.604	0.578	0.556	805
EN:	0.667	0.650	0.609	0.645	0.335	0.307	0.614	0.570	0.707	0.725	781
FC:	0.649	0.706	0.625	0.696	0.417	0.392	0.492	0.680	0.699	0.691	727
GMG:	0.600	0.698	0.629	0.633	0.377	0.336	0.480	0.634	0.629	0.615	393
11H-H:	0.263	0.245	0.264	0.316	0.088	0.097	0.310	0.257	0.353	0.334	554
11H-I:	0.341	0.298	0.311	0.344	0.310	0.228	0.261	0.279	0.387	0.341	320
BT/MM:	0.484	0.453	0.378	0.451	0.250	0.246	0.433	0.424	0.511	0.500	837
OS:	0.627	0.723	0.613	0.705	0.498	0.523	0.388	0.718	0.646	0.565	622
RM:	0.658	0.674	0.622	0.635	0.415	0.425	0.333	0.591	0.591	0.542	250
13F:	0.620	0.697	0.609	0.707	0.437	0.471	0.488	0.631	0.678	0.587	819
19K:	0.203	0.192	0.143	0.189	0.186	0.170	0.131	0.208	0.191	0.148	1106
272-1:	0.608	0.663	0.674	0.701	0.354	0.333	0.464	0.558	0.639	0.602	484
732:	0.708	0.775	0.693	0.771	0.479	0.432	0.437	0.713	0.648	0.585	421

	CT:	SM:	FR:	ID:	AO:	SO:	N;
AC:	0.507	0.459	0.580	0.338	0.483	0.481	72
AE:	0.482	0.429	0.499	0.401	0.492	0.515	173
AMS:	0.395	0.388	0.513	0.381	0.458	0.493	244
AO:	0.386	0.318	0.467	0.328	0.439	0.446	233
AV:	0.488	0.442	0.529	0.378	0.461	0.479	197
EM:	0.420	0.342	0.465	0.327	0.378	0.438	805
EN:	0.385	0.321	0.484	0.357	0.436	0.501	781
FC:	0.429	0.392	0.551	0.388	0.478	0.530	727
GMG:	0.465	0.368	0.525	0.350	0.426	0.491	393
11H-H:	0.218	0.185	0.218	0.178	0.273	0.302	554
11H-I:	0.249	0.284	0.216	0.220	0.264	0.324	320
BT/MM:	0.298	0.254	0.408	0.272	0.384	0.326	837
OS:	0.529	0.468	0.559	0.380	0.464	0.524	622
RM:	0.463	0.445	0.468	0.361	0.412	0.473	250
13F:	0.508	0.477	0.583	0.417	0.520	0.571	819
19K:	0.149	0.141	0.111	0.111	0.155	0.136	1106
272-1:	0.480	0.416	0.492	0.345	0.451	0.537	484
732:	0.478	0.502	0.603	0.388	0.452	0.551	421

Table F-19

Testing Condition A_8: B_5 (3.00)

DATA FILE: B5-180P1.DAT
CAT-ASVAB + ALL ECAT TESTS SECOND HORST 180 MIN INTERCORRELATIONS

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:
GS:	0.657	0.805	0.760	0.298	0.268	0.588	0.608	0.749	0.781
AR:		0.634	0.684	0.485	0.405	0.431	0.738	0.686	0.579
WK:			0.905	0.348	0.349	0.488	0.539	0.636	0.661
PC:				0.475	0.460	0.424	0.606	0.631	0.615
NO:					0.661	0.051	0.522	0.257	0.174
CS:						0.063	0.426	0.247	0.175
AS:							0.216	0.726	0.837
MK:								0.563	0.448
MC:									0.819
EI:									

	CT:	SM:	FR:	ID:	AO:	SO:	T1:	T2:	TI:	MEAN:	SD:
GS:	0.368	0.352	0.524	0.332	0.417	0.505	-0.318	-0.371	-0.338	0.000	1.000
AR:	0.528	0.486	0.594	0.358	0.430	0.529	-0.311	-0.347	-0.269	0.000	1.000
WK:	0.337	0.351	0.492	0.281	0.347	0.449	-0.270	-0.323	-0.269	0.000	1.000
PC:	0.385	0.396	0.513	0.283	0.349	0.449	-0.281	-0.317	-0.266	0.000	1.000
NO:	0.354	0.322	0.310	0.162	0.200	0.224	-0.222	-0.203	-0.189	0.000	1.000
CS:	0.330	0.316	0.288	0.160	0.222	0.236	-0.214	-0.222	-0.202	0.000	1.000
AS:	0.206	0.162	0.324	0.251	0.344	0.406	-0.288	-0.348	-0.244	0.000	1.000
MK:	0.499	0.457	0.554	0.330	0.398	0.484	-0.276	-0.290	-0.236	0.000	1.000
MC:	0.442	0.381	0.579	0.394	0.511	0.601	-0.426	-0.490	-0.365	0.000	1.000
EI:	0.296	0.254	0.447	0.313	0.416	0.492	-0.325	-0.390	-0.274	0.000	1.000
CT:		0.528	0.517	0.321	0.445	0.460	-0.371	-0.368	-0.282	0.000	1.000
SM:			0.483	0.279	0.369	0.403	-0.306	-0.307	-0.258	0.000	1.000
FR:				0.365	0.472	0.523	-0.358	-0.371	-0.292	0.000	1.000
ID:					0.336	0.349	-0.247	-0.257	-0.207	0.000	1.000
AO:						0.471	-0.334	-0.362	-0.309	0.000	1.000
SO:							-0.372	-0.399	-0.276	0.000	1.000
T1:								0.808	0.396	0.000	1.000
T2:									0.401	0.000	1.000
TI:										0.000	1.000

Table F-20

Testing Condition A_8: B_5 (3.00)

DATA FILE: B5-180C1.DAT
CAT-ASVAB + ALL ECAT TESTS SECOND HORST 180 MIN VALIDITIES

	GS:	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:	N:
AC:	0.670	0.738	0.554	0.678	0.469	0.508	0.367	0.805	0.553	0.598	72
AE:	0.623	0.586	0.573	0.550	0.325	0.361	0.478	0.582	0.604	0.631	173
AMS:	0.752	0.680	0.731	0.707	0.412	0.439	0.564	0.635	0.720	0.706	244
AO:	0.581	0.595	0.529	0.596	0.413	0.415	0.380	0.637	0.514	0.545	233
AV:	0.650	0.742	0.639	0.680	0.406	0.377	0.447	0.706	0.581	0.698	197
EM:	0.572	0.625	0.513	0.532	0.367	0.354	0.374	0.602	0.572	0.554	805
EN:	0.667	0.640	0.608	0.642	0.333	0.307	0.612	0.569	0.700	0.723	781
FC:	0.649	0.694	0.624	0.693	0.414	0.392	0.490	0.678	0.692	0.689	727
GMG:	0.600	0.687	0.628	0.630	0.374	0.336	0.478	0.633	0.623	0.613	393
11H-H:	0.263	0.241	0.264	0.315	0.087	0.097	0.309	0.257	0.349	0.333	554
11H-I:	0.341	0.293	0.310	0.343	0.308	0.228	0.260	0.278	0.383	0.340	320
BT/MM:	0.484	0.446	0.377	0.449	0.249	0.246	0.431	0.423	0.506	0.499	837
OS:	0.627	0.711	0.612	0.702	0.495	0.523	0.387	0.716	0.640	0.564	622
RM:	0.658	0.663	0.621	0.632	0.412	0.425	0.331	0.590	0.586	0.540	250
13F:	0.620	0.685	0.608	0.704	0.434	0.471	0.486	0.629	0.671	0.585	819
19K:	0.203	0.189	0.142	0.188	0.185	0.171	0.130	0.208	0.189	0.147	1106
272-1:	0.608	0.652	0.673	0.698	0.352	0.333	0.462	0.556	0.633	0.601	484
732:	0.708	0.762	0.692	0.768	0.476	0.432	0.436	0.712	0.642	0.583	421

	CT:	SM:	FR:	ID:	AO:	SO:	T1:	T2:	TI:	N;
AC:	0.506	0.450	0.579	0.300	0.440	0.468	-0.238	-0.286	-0.240	72
AE:	0.481	0.421	0.498	0.355	0.448	0.502	-0.382	-0.353	-0.369	173
AMS:	0.394	0.381	0.512	0.338	0.417	0.480	-0.312	-0.355	-0.295	244
AO:	0.385	0.312	0.466	0.291	0.400	0.435	-0.373	-0.323	-0.345	233
AV:	0.486	0.434	0.528	0.335	0.420	0.467	-0.273	-0.378	-0.273	197
EM:	0.419	0.335	0.464	0.290	0.344	0.427	-0.271	-0.297	-0.186	805
EN:	0.384	0.315	0.483	0.317	0.397	0.489	-0.323	-0.366	-0.295	781
FC:	0.428	0.385	0.550	0.344	0.435	0.517	-0.280	-0.365	-0.223	727
GMG:	0.463	0.362	0.524	0.310	0.388	0.478	-0.317	-0.346	-0.195	393
11H-H:	0.217	0.182	0.218	0.158	0.248	0.294	-0.240	-0.277	-0.213	554
11H-I:	0.248	0.278	0.215	0.195	0.240	0.316	-0.385	-0.413	-0.280	320
BT/MM:	0.297	0.250	0.407	0.241	0.349	0.318	-0.274	-0.240	-0.214	837
OS:	0.527	0.460	0.558	0.337	0.423	0.511	-0.305	-0.363	-0.266	622
RM:	0.461	0.437	0.467	0.320	0.375	0.461	-0.219	-0.255	-0.112	250
13F:	0.507	0.468	0.582	0.369	0.473	0.556	-0.391	-0.407	-0.333	819
19K:	0.148	0.139	0.111	0.098	0.141	0.132	-0.135	-0.127	-0.113	1106
272-1:	0.479	0.409	0.491	0.305	0.411	0.524	-0.369	-0.372	-0.354	484
732:	0.476	0.493	0.602	0.344	0.412	0.537	-0.245	-0.271	-0.243	421

Appendix G

Factor Analysis Results

Table G-1

Estimated True-Score Factor Scores:

--EIGENVALUE SUMMARY REPORT--

FACTOR	EIGENVALUE	PCT OF VAR	CUM PCT
1	10.18589	53.61	53.61
2	1.988704	10.47	64.08
3	1.724733	9.08	73.15
4	1.159964	6.11	79.26
5	.69208	3.64	82.9
6	.630049	3.32	86.22
7	.449483	2.37	88.58
8	.40335	2.12	90.71
9	.296031	1.56	92.26
10	.266105	1.4	93.67
11	.233932	1.23	94.9
12	.212813	1.12	96.02
13	.206597	1.09	97.1
14	.196621	1.03	98.14
15	.166402	.88	99.01
16	.119208	.63	99.64
17	.100537	.53	100.17
18	.09325	.49	100.66

Table G-2

```
POPULATION TRUE SCORE FACTOR LOADINGS:
 19
 16
 0.833613-0.262223 0.293634-0.076907-0.072885-0.162812-0.064591 0.002910 0.026627 0.091454 0.049794-0.058924 0.118721 0.070471 0.228076-0.099478
 0.876508 0.125967 0.211484 0.096539 0.062532-0.008168-0.159112-0.183529-0.024461-0.031190-0.019197 0.043554 0.124829-0.100178-0.220792-0.033148
 0.775010-0.131997 0.415116-0.173658-0.045970-0.326694 0.163519 0.131841 0.012260 0.050160-0.044876 0.051201 0.110375-0.003430-0.057013 0.028664
 0.812450 0.028842 0.427987-0.191297-0.019712-0.251557 0.126438 0.090927 0.004187 0.022162-0.044278 0.046909 0.115707-0.015090-0.083370 0.042673
 0.513047 0.625446 0.241031-0.318405 0.048674 0.261690-0.082620-0.055062 0.034677-0.035807-0.119111 0.187910 0.073068 0.222063 0.039841-0.043397
 0.505534 0.593589 0.194934-0.347831 0.006653 0.312272 0.165986 0.175114-0.021119-0.023179 0.120602-0.164642 0.071996-0.179827 0.031924 0.011383
 0.612446-0.639804 0.087954-0.087232 0.047649 0.336393 0.143719-0.163556-0.002796-0.053335-0.027180 0.032635 0.087223-0.002479-0.031359 0.071354
 0.772942 0.300499 0.204207 0.124642 0.056740-0.082302-0.412249-0.109719-0.035324 0.075546 0.099369-0.129894 0.110081-0.000373 0.017766 0.093430
 0.883753-0.333484 0.036890 0.023060 0.029758 0.135970-0.069367-0.054595-0.006391-0.043263 0.015232-0.017905 0.125862-0.049133-0.045991-0.076510
 0.769350-0.520118 0.203240-0.076079 0.046508 0.172676 0.014861-0.096173 0.019051 0.019249 0.030008-0.059859 0.109569 0.023953 0.083659 0.028816
 0.736979 0.328711-0.249610 0.268231 0.023954 0.012412 0.170164-0.183841-0.000805 0.241283-0.262469-0.025502 0.104958-0.125183 0.082998-0.011851
 0.708318 0.356751-0.166626 0.255525-0.029108-0.138609 0.313253-0.263059-0.061303-0.080078 0.259659 0.028591 0.100877 0.108510 0.008456-0.001503
 0.825188 0.106996-0.086137 0.266212 0.000266-0.102144-0.003398 0.071046 0.165865-0.376010-0.162969-0.119705 0.117522 0.000926 0.057258-0.000101
 0.819589-0.015185-0.189013 0.279328-0.027078 0.083266-0.082654 0.187704 0.203341 0.036151 0.141442 0.275290 0.116722-0.143988 0.062265-0.004137
 0.796987-0.026635-0.264346 0.258313-0.084829 0.161662 0.045488 0.236380 0.131350 0.172196 0.010951-0.139681 0.113506 0.216425-0.145052 0.022720
 0.803029-0.068628-0.149112 0.235483 0.068642 0.052072-0.031447 0.235368-0.444504-0.055639-0.044298 0.061744 0.114365 0.024761 0.036449-0.003175
-0.570221 0.023004 0.608562 0.409911-0.240677 0.135433 0.044487 0.013262-0.022212 0.006494 0.008556-0.034372-0.081209-0.014607-0.044625-0.203981
-0.602369 0.087634 0.568236 0.411411-0.244986 0.123715 0.030122-0.002293-0.010815-0.011847-0.033226 0.046870-0.085788 0.011769 0.060840 0.201713
-0.481881 0.016637 0.362666 0.283808 0.733074 0.001923 0.085930 0.067536 0.056428 0.029953 0.022242-0.009013-0.068628 0.027427 0.015367-0.008389
```

Appendix H
Mean Predicted Performance
by Test Condition for Eight Replications

Table H-1

Mean Predicted Performance
by Test Condition for Eight Replications

	Conditions							
	A1	A2	A3	A4	A5	A6	A7	A8
Replications								
1	.60	.68	.64	.73	.66	.68	.74	.76
2	.56	.62	.58	.65	.60	.59	.66	.71
3	.61	.63	.65	.70	.60	.65	.68	.76
4	.53	.65	.62	.69	.58	.59	.69	.73
5	.64	.64	.64	.67	.64	.63	.71	.73
6	.66	.71	.67	.80	.65	.69	.76	.78
7	.54	.57	.53	.60	.55	.58	.65	.65
8	.66	.70	.68	.73	.68	.70	.79	.79

Table 1

ASVAB, CAT-ASVAB, Alternate Batteries, and Their Individual Tests

Test	Battery[1]				
ASVAB/CAT-ASVAB	B_1	B_2	B_3	B_4	B_5
1. General Science	p	ca	p	ca	ca
2. Arithematic Reasoning	p	ca	p	ca	ca
3. Work Knowledge	p	ca	p	ca	ca
4. Paragraph Comprehension	p	ca	p	ca	ca
5. Numerical Operations	p	cn	p	cn	cn
6. Coding Speed	p	cn	p	cn	cn
7. Auto and Shop Information	p	ca	p	ca	ca
8. Mathematical Knowledge	p	ca	p	ca	ca
9. Mechanical Comprehension	p	ca	p	ca	ca
10. Electronics Information	p	ca	p	ca	ca
ECAT					
1. Mental Counters				cn	cn
2. Sequential Memory				cn	cn
3. Figural Reasoning			p	cn	cn
4. Integrating Details				cn	cn
5. Assembling Objects			p	cn	cn
6. Spatial Orientation			p	cn	cn
7. One-Hand Tracking					cnp
8. Two-Hand Tracking					cnp
9. Target Identification					cnp

[1]Mode of Administration for Each Test:

p = paper-and-pencil
ca = computer-adaptive
cn = computer non-adaptive
cnp = computer non-adaptive with response pedestal

Table 2

Test Battery and Time Limits for Each Treatment[1]

Testing Condition[1]	Battery	Time (minutes)
A_1	B_1	100
A_2	B_2	100
A_3	B_3	135
A_4	B_4	135
A_5	B_1	180
A_6	B_3	180
A_7	B_4	180
A_8	B_5	180

[1]Legend for Testing Conditions:

A_1: P&P-ASVAB, 100 min.
A_2: CAT ASVAB, 100 min.
A_3: P&P-ASVAB + P&P-ECAT, 135 min.
A_4: CAT ASVAB + non-pedestal ECAT, 135 min.
A_5: P&P-ASVAB, 180 min.
A_6: P&P-ASVAB + P&P-ECAT, 180 min.
A_7: CAT-ASVAB + non-pedestal ECAT, 180 min.
A_8: CAT ASVAB + full ECAT, 180 min.

Table 3

Battery Contrasts

SOW Task No.	Contrasts[1]	Expected Completion Time (minutes)
4.4.1	A_1 vs A_2	100
4.4.2	A_3 vs A_4	135
4.4.3	A_5 vs A_6	180
4.4.4	A_6 vs A_7	180
4.4.5	A_7 vs A_8	180
4.4.6	A_6 vs A_8	180

[1]Legend for Testing Conditions:

A_1: P&P-ASVAB, 100 min.
A_2: CAT ASVAB, 100 min.
A_3: P&P-ASVAB + P&P-ECAT, 135 min.
A_4: CAT ASVAB + non-pedestal ECAT, 135 min.
A_5: P&P-ASVAB, 180 min.
A_6: P&P-ASVAB + P&P-ECAT, 180 min.
A_7: CAT-ASVAB + non-pedestal ECAT, 180 min.
A_8: CAT ASVAB + full ECAT, 180 min.

Table 4

Coefficients for the Six Planned Comparisons

	P&P ASVAB		P&P ASVAB + P&P-ECAT		CAT ASVAB	CAT ASVAB + ECAT (non-ped)		CAT ASVAB + ECAT (full)
	A_1	A_5	A_3	A_6	A_2	A_4	A_7	A_8
Completion Time (minutes)	100	180	135	180	100	135	180	180
<u>Hypotheses:</u>								
4.4.1	-1				1			
4.4.2			-1			1		
4.4.3		-1		1				
4.4.4				-1			1	
4.4.5							-1	1
4.4.6				-1				1

Table 5

Experimental Design

Testing Condition:	Replications (Blocks): B_1	B_2	... B_M
A_1 [B_1(100)]	$PP_{1,1}$	$PP_{1,2}$	... $PP_{1,M}$
A_2 [B_2(100)]	$PP_{2,1}$	$PP_{2,2}$	... $PP_{2,M}$
A_3 [B_3(135)]	$PP_{3,1}$	$PP_{3,2}$	... $PP_{3,M}$
A_4 [B_4(135)]	$PP_{4,1}$	$PP_{4,2}$	... $PP_{4,M}$
A_5 [B_1(180)]	$PP_{5,1}$	$PP_{5,2}$	... $PP_{5,M}$
A_6 [B_3(180)]	$PP_{6,1}$	$PP_{6,2}$	... $PP_{6,M}$
A_7 [B_4(180)]	$PP_{7,1}$	$PP_{7,2}$	... $PP_{7,M}$
A_8 [B_5(180)]	$PP_{8,1}$	$PP_{8,2}$	... $PP_{8,M}$

Table 6

Joint-Service Schools

Abbreviation	Title
Navy:	
AC	Air Controlman
AE	Aviation Electrician's Mate
AMS	Aviation Structural Mechanic-Structures
AO	Aviation Ordinanceman
AV	Avionics Total, consisting of:
	Aviation Electronics Technician (AT)
	Aviation Fire Control Technician (AQ)
	Aviation Antisubmarine Warfare Technician (AX)
EN	Engineman
EM	Electrician's Mate
FC	Fire Control Technician
GMG	Gunner's Mate
BT/MM	Boiler Technician/Machinist's Mate
OS	Operations Specialist
RM	Radioman
Air Force:	
272	Air Traffic Controller
732	Personnel Specialist
Army:	
13F	Ft. Sill - Artillery Specialist
11H(H)*	Ft. Benning - Tow Missile Specialist
11H(I)*	
19K	Ft. Knox - M1 Tank Crewman

* 11H data was separated into two samples reflecting separate school tracks, I and H. Each track sample was analyzed as if it were a separate school sample.

Table 7

Optimal Test Times (minutes) for the Eight Testing Conditions

	Testing Condition:							
Test:	A_1: B_1	A_2: B_2	A_3: B_3	A_4: B_4	A_5: B_1	A_6: B_3	A_7: B_4	A_8: B_5
GS:	9.06	7.84	11.11	8.884	15.574	14.308	9.990	9.972
AR:	16.22	14.04	17.13	14.595	26.172	22.046	16.908	13.497
WK:	10.45	8.88	11.59	10.017	16.453	14.596	12.854	11.783
PC:	4.58	17.95	8.04	22.512	21.500	16.499	32.188	28.761
NO:	3.35	3.11	3.77	3.426	4.924	4.552	4.701	4.137
CS:	7.13	5.42	7.84	5.854	9.888	9.198	7.969	8.113
AS:	8.28	6.38	9.38	7.365	12.744	11.604	8.840	8.108
MK:	14.97	7.78	15.94	8.103	20.314	18.445	9.126	8.653
MC:	12.04	14.93	14.00	17.318	25.834	21.457	23.070	19.648
EI:	13.92	13.67	17.13	15.536	26.597	23.584	20.381	18.641
CT:				3.612			5.187	5.146
SM:				4.753			7.311	6.681
FR:			8.13	5.771		9.951	9.093	8.958
ID:				.475			2.165	1.588
AO:			3.33	2.793		4.770	4.824	2.885
SO:			7.59	3.986		8.991	5.423	4.564
T1:								8.385
T2:								5.938
TI:								4.541

<u>Note</u>. The batteries B_2, B_4, and B_5 are computer administered. At the completion of one test, the examinee may proceed immediately to the next without regard to time limits. Therefore, the time limits for the individual tests do not constrain total administration time, and expected administration time is the appropriate measure.

Table 8.

CAT-ASVAB Original Test Lengths, and Lengths and Reliabilities for Proportionally Lengthened tests to achieve 100 minutes Testing Time

	Original		Revised	
Test:	Length:	Reliability:	Length:	Reliability:
GS:	4.712	.88	5.591	.90
AR:	20.973	.92	24.890	.94
WK:	4.112	.91	4.880	.92
PC:	13.604	.84	16.144	.87
NO:	3.000	.86	3.560	.88
CS:	7.000	.82	8.307	.84
AS:	6.196	.92	7.353	.93
MK:	9.461	.93	11.228	.95
MC:	10.787	.87	12.801	.88
EI:	4.419	.82	5.244	.84
SUMS:	84.264		99.998	

Table 9

Matrix of Estimated Predictor True-Score Intercorrelations

Z-Score Means, Standard Deviations, and Intercorrelations among ASVAB and ECAT Tests, Corrected for Restriction in Range and Attenuation

	AR:	WK:	PC:	NO:	CS:	AS:	MK:	MC:	EI:
GS:	0.723	0.838	0.810	0.324	0.300	0.623	0.648	0.798	0.820
AR:		0.689	0.761	0.550	0.473	0.477	0.822	0.763	0.636
WK:			0.953	0.373	0.386	0.511	0.568	0.669	0.686
PC:				0.522	0.520	0.455	0.655	0.680	0.654
NO:					0.762	0.056	0.574	0.282	0.188
CS:						0.071	0.483	0.280	0.195
AS:							0.231	0.778	0.884
MK:								0.607	0.477
MC:									0.871
EI:									

	CT:	SM:	FR:	ID:	AO:	SO:	T1:	T2:	TI:	MEAN:	SD:
GS:	0.437	0.442	0.612	0.605	0.565	0.603	-0.343	-0.394	-0.366	0.000	1.000
AR:	0.655	0.638	0.725	0.681	0.608	0.660	-0.351	-0.385	-0.304	0.000	1.000
WK:	0.395	0.436	0.568	0.506	0.465	0.529	-0.287	-0.339	-0.287	0.000	1.000
PC:	0.463	0.503	0.606	0.523	0.478	0.542	-0.307	-0.340	-0.291	0.000	1.000
NO:	0.433	0.416	0.373	0.305	0.279	0.275	-0.246	-0.222	-0.211	0.000	1.000
CS:	0.417	0.421	0.358	0.310	0.320	0.299	-0.245	-0.250	-0.232	0.000	1.000
AS:	0.246	0.205	0.381	0.459	0.468	0.487	-0.313	-0.372	-0.266	0.000	1.000
MK:	0.600	0.581	0.656	0.609	0.546	0.585	-0.302	-0.312	-0.258	0.000	1.000
MC:	0.531	0.485	0.685	0.727	0.700	0.726	-0.465	-0.526	-0.399	0.000	1.000
EI:	0.351	0.318	0.521	0.569	0.562	0.585	-0.350	-0.412	-0.296	0.000	1.000
CT:		0.748	0.681	0.661	0.680	0.620	-0.451	-0.441	-0.345	0.000	1.000
SM:			0.674	0.606	0.596	0.573	-0.393	-0.389	-0.333	0.000	1.000
FR:				0.739	0.710	0.692	-0.428	-0.437	-0.351	0.000	1.000
ID:					0.787	0.720	-0.460	-0.471	-0.389	0.000	1.000
AO:						0.722	-0.464	-0.494	-0.431	0.000	1.000
SO:							-0.455	-0.479	-0.339	0.000	1.000
T1:								0.879	0.439	0.000	1.000
T2:									0.437	0.000	1.000
TI:										0.000	1.000

Table 10

Actual Enrollment Numbers and Assignment Quotas by School

School	Actual Enrollment	School Assignment Quota
AC	607	1
AE	1016	2
AMS	1067	2
AO	1158	3
AV	2138	5
EM	4586	10
EN	1334	3
FC	874	2
GMG	346	1
11H(H)	872	2
11H(I)	331	1
MM	6422	15
OS	1176	3
RM	1410	3
13F	1581	4
19K	2307	5
272	470	1
732	868	2
SUBTOTAL	28563	65
REJECTS[1]		35
TOTAL	28563	100

[1] To accurately reflect the population selection ratio of .652 (based on FY 92 data), the assignment algorithm optimally classified 65 of the 100 subjects to schools while allocating the remaining 35 subjects to the reject category.

Table 11

Job Values by Job Complexity Ratings for the 17 Occupational Specialties

Job Complexity Level	Occupational Specialty	Per Person Job Value	Mean Job Value by Complexity
1	27230	128,698.51	
	AC	130,426.90	
	OS	127,791.98	128,972.46
2	AMS	126,997.49	
	GMG	121,187.10	
	73230	130,418.76	
	AE	130,176.66	
	AV	132,757.99	
	MM	140,131.90	
	AO	125,129.15	
	EN	133,955.73	
	EM	135,456.19	
	FC	135,910.52	
	RM	128,018.92	130,921.86
3	13F	104,406.45	
	11H	106,674.27	
	19K	103,639.08	104,906.60

Table 12

Military and Civilian Pay by Job Complexity Category

Complexity Category	MILITARY Job	Mean Monthly Salary	Mean Salary by Category	CIVILIAN Job	Mean[1] Monthly Salary	Mean Salary by Category
1	27230	1,928				
	OS	1,915		Attorney	6,829	
	AC	1,954	1,932	Physician[2]	9,287	8,056
2	AMS	1,930				
	GMG	1,816				
	73230	1,954				
	AE	1,950				
	AV	1,989				
	MM	2,100				
	AO	1,875				
	EN	2,007		Auto Mech	3,100	
	EM	2,029		Repairman	2,865	
	RM	1,918	1,962	FC	2,036	2,982
				Clerks	1,575	
3	13F	1,564		Mail Hndlr	1,537	
	11H	1,598		Tel Operatr	1,652	
	19K	1,553	1,572	File Clerk	1,398	1,539

Note. The civilian jobs appearing in this table represent our attempt to match as many civilian jobs as appeared in the job complexity categories of Hunter, Schmidt, & Judiesch (1990, Table 5, p. 34).

[1] Mean monthly salaries obtained from Employers' Group Salary Survey covering Southern California (November 1993).

[2] Mean monthly salary computed from data presented in Hunter, Schmidt, & Judiesch (1990) based on Ovens (1987) national survey of the earnings of nonsalaried Physicians.

Table 13

Job Values by Job Complexity Ratings for the 16 MOSs from Bobko & Donnelly (1988)

Job Complexity Level	Occupational Specialty	Per Person Job Value	Mean Job Value by Complexity
2	71L	119,062.54	
	55B	101,062.50	
	51B	103,324.33	
	94B	106,697.44	
	63B	115,087.37	
	91B	133,339.38	
	95B	108,206.83	
	64C	290,984.77	
	27E	102,984.80	
	76Y	125,089.95	
	67N	114,310.94	129,104.62
3	13B	100,524.31	
	12B	103,081.87	
	11B	108,855.34	
	19E	128,764.09	110,306.40

Table 14

Complexity and SDy Values for the 17 Occupational Specialties

Job Complexity Level	Occupational Specialty	SDp Value	Per Person Job Value	SDy Value
1	27230	.48	128,698.51	61,131.79
	AC	.48	130,426.90	61,952.78
	OS	.48	127,791.98	60,701.19
2	AMS	.32	126,997.49	40,385.20
	GMG	.32	121,187.10	38,537.50
	73230	.32	130,418.76	41,473.17
	AE	.32	130,176.66	41,396.18
	AV	.32	132,757.99	42,217.04
	MM	.32	140,131.90	44,561.94
	AO	.32	125,129.15	39,791.07
	EN	.32	133,955.73	42,597.92
	EM	.32	135,456.19	43,075.07
	FC	.32	135,910.52	43,219.55
	RM	.32	128,018.92	40,710.02
3	13F	.19	104,406.45	20,150.44
	11H	.19	106,674.27	20,588.13
	19K	.19	103,639.08	20,002.34

Table 15

An Overview of Steps to Compute Total Net Benefits (TNB)

Complexity Category	Job	SD_y	WMPP[1] by Battery (a)	WMPP[1] by Battery (b)	$N_{Per\ School}$	$\Delta U_{Total(Per\ School)}$[2] by Battery (a)	$\Delta U_{Total(Per\ School)}$[2] by Battery (b)
1	44E	49204.42	1.255	1.207	148	9,139,229	8,789,681
	AC	61952.78	1.255	1.207	607	47,194,699	45,389,642
	45510	56141.31	1.255	1.207	117	8,243,509	7,928,220
	.						
	.						
	.						
2	2800	25383.92	.595	.668	646	9,756,817	10,953,872
	29N	31502.84	.595	.668	193	3,617,629	4,061,472
	SK	34181.79	.595	.668	636	16,340,853	18,345,697
	45214	39986.41	.595	.668	1023	24,339,128	27,325,273
	.						
	.						
	.						
3	EO	22991.07	.357	.348	349	2,864,526	2792,311
	5831	22814.51	.357	.348	118	961,084	936,855
	91F	19769.70	.357	.348	186	1,312,748	1279,653
	.						
	.						
	.						
					$\Delta U_{Total(a)}$[3] =	4,923,020,576	
					$\Delta U_{Total(b)}$[3] =		5,378,991,338
					$TNB = \Delta U_{Total(b)} - \Delta U_{Total(a)}$ =		455,970,762

Note. Battery a = Paper & Pencil, Battery b = CAT.

[1] WMPP values are the same for each school in a complexity category but different for each battery.

[2] This is the product of $\Delta \bar{U}_s * N_{Per\ School}$ for each battery.

[3] These are column sums.

Table 16

Overview of Procedures for Present Value Analyses

Project Year	Fiscal Year[1] (Cohort No.)	Initial[2] Setup Costs	4-Year TNB[3] Per Cohort	Mid-Year Discount[4] Factor (4th Year of Cohort)	Present Value[5] of TNB
1	1995	( )			( )
2	1996				
3	1997 (1)			0.6442	
4	1998 (2)			0.6020	
5	1999 (3)			0.5626	
6	2000 (4)			0.5258	______
				Net Present Value of One Selection program over the Alternative:	______

[1] Each row represents one of the six years in the project. The four numbers in parentheses show the four cohorts planned during the life cycle of an ASVAB form. The enlisted personnel selected with an ASVAB form during a given year constitutes one cohort.

[2] NPRDC plans setup costs over the first three project years. We show them all in the first year to clearly indicate the total projected investment costs and to conservatively conduct these analyses.

[3] Each 1-year cohort has an average tenure of 46.28 months or 3.86 years. Amounts in this column equal 3.86 times the TNB.

[4] Values in this column represent the appropriate discount factor for the middle of the fourth year for a given cohort. These are the mid-year discount factors for project years seven through ten.

[5] This column accummulates the present values of the TNB terms. Since we did not discount the setup costs, this investment appears unchanged. For each of the four cohort years, the value in this column is the product of the 4-year TNB (from the second column) and the discount factor (from the fourth column). The net present value at the bottom of this column is simply the sum of the column values.

Table 17

Initial Setup Costs for Various Batteries (in $K)

	P&P ASVAB		P&P ASVAB + P&P ECAT		CAT ASVAB	CAT ASVAB + ECAT (non-ped)		CAT ASVAB + ECAT (full)
	A_1	A_5	A_3	A_6	A_2	A_4	A_7	A_8
Completion Time (minutes)	100	180	135	180	100	135	180	180
PERSONNEL								
Res & Dev					1960	1960	1960	1960
Software Dev/Mtc					1475	1475	1475	1475
CONTRACTS								
Eq & Freight[1]					5627	7627	10169	10169
Resp Pedestals								2100
Maintenance[1]					593	804	1072	1072
Programming Supt					270	270	270	270
Training					300	300	300	300
Equating Data Coll					250	250	250	250
OTHER								
Res & Dev					100	100	100	100
Computer Supt/Supplies[1]					162	220	293	293
Site Support					200	200	200	200
TOTALS					10937	13206	16089	18189
ADJUSTED TOTALS[2]					11603	14010	17069	19297

Note. Data appearing in Vicino, Hetter, Moreno, Rafacz, Segall, and Unpingco (1993) served as a basis for this table. Interpolations or extrapolations based on their cost data (based on a 2-hour test) and our test completion times provided the data for this table.

[1] These costs vary directly with test completion time. All other costs are as presented in Vicino et al.

[2] Vicino et al. present their cost estimates in 1993 dollars. The adjusted totals in this row represent an additional 3% per year to place them in 1995 dollars.

Table 18

Mean Classification Efficiency Indices[1] Across Replications for Each Testing Condition (TC)

TC	Battery	Time	Phi	R′	r′	C	AA	G
A_1	B_1	100	.9926	.6908	.9266	.1872	.3948	.3912
A_2	B_2	100	1.3079	.7178	.8919	.2360	.4977	.4065
A_3	B_3	135	1.1039	.7029	.9101	.2108	.4446	.3981
A_4	B_4	135	1.4738	.7302	.8728	.2604	.5492	.4135
A_5	B_1	180	1.1366	.7045	.9102	.2111	.4452	.3990
A_6	B_3	180	1.1843	.7098	.9011	.2232	.4707	.4020
A_7	B_4	180	1.6000	.7398	.8598	.2762	.5825	.4178
A_8	B_5	180	1.7789	.7449	.8399	.2980	.6285	.4218

1 Notation for Indices Above:

Phi: Horst's index of differential validity.
R′: The average multiple correlation across schools.
r′: The average correlation between regression equations across schools.
C: The multiplier for Brogden's Allocation Average Index.
AA: Brogden's Allocation Average.
G: The Allocation Average using a single factor as a predictor.

Table 19

Analysis of Variance on Mean Predicted Performance Values

SV	SS	df	MS	*F*
A	.1356	7	.0194	50.46***
B	.1179	7	.0169	
A x B	.0188	49	.0004	
Total	.2723	63		

***$p<.001$.

Table 20

Significance Tests for Planned Comparisons

SOW	SV	d	t
4.4.1	A1 v. A2	.0486	4.96***
4.4.2	A3 v. A4	.0697	7.11***
4.4.3	A5 v. A6	.0188	1.92*
4.4.4	A6 v. A7	.0714	7.29***
4.4.5	A7 v. A8	.0314	3.20**
4.4.6	A6 v. A8	.1028	10.49***
SE_{diff}	.0098		

*$p<.05$, one-tailed.
**$p<.01$, one-tailed.
***$p<.001$, one-tailed.

Table 21

Allocation Averages (Mean Predicted Performance) for the Six Planned Comparisons

	P&P ASVAB		P&P ASVAB + P&P-ECAT		CAT ASVAB	CAT ASVAB + ECAT (non-ped)		CAT ASVAB + ECAT (full)
	A_1	A_5	A_3	A_6	A_2	A_4	A_7	A_8
Completion Time (minutes)	100	180	135	180	100	135	180	180
<u>Hypotheses:</u>								
4.4.1	.60				.65			
4.4.2			.62			.69		
4.4.3		.62		.64				
4.4.4				.64			.71	
4.4.5							.71	.74
4.4.6				.64				.74

<u>Note</u>. Tabled MPP values are based only on our sample of 18 jobs.

Table 22

Average Mean Predicted Performance (MPP)
by Testing Condition and Research Question

	P&P ASVAB		P&P ASVAB + P&P ECAT		CAT ASVAB	CAT ASVAB + ECAT (non-ped)		CAT ASVAB + ECAT (full)	
	A_1	A_5	A_3	A_6	A_2	A_4	A_7	A_8	$Delta_{MPP}$
Completion Time (minutes)	100	180	135	180	100	135	180	180	
Hypothesis:									
4.4.1	.57 (.88)				.62 (.97)				.10 (.17)
4.4.2			.60 (.91)			.67 (1.05)			.07 (.13)
4.4.3		.59 (.91)		.61 (.96)					.02 (.04)
4.4.4				.61 (.96)			.68 (1.07)		.08 (.12)
4.4.5							.68 (1.07)	.71 (1.11)	.03 (.04)
4.4.6				.61 (.96)				.71 (1.11)	.11 (.15)

Note. These MPP values are the result of applying our generalizing formulas (see pages 47 and 48) and reflect our estimated MPP values for all 622 entry-level jobs in the military. Values in parentheses are the average MPPs multiplied by the Brogden factors appearing in Table 23.

Table 23

Observed and Estimated Mean Predicted Performance Values (Brogden's AA)

	Brogden		Multiplication Factor	Observed	
N Jobs:	18	622		18	622
Treatment Condition:					
A_1	.40	.62	1.550	.60	.930
A_2	.50	.78	1.560	.65	1.014
A_3	.45	.69	1.533	.63	.966
A_4	.55	.86	1.564	.70	1.095
A_5	.45	.70	1.556	.62	.964
A_6	.47	.74	1.574	.64	1.008
A_7	.58	.91	1.569	.71	1.114
A_8	.63	.98	1.556	.74	1.151

Table 24

Utilities (in $M)
by Testing Condition and Research Question

	P&P ASVAB		P&P ASVAB + P&P ECAT		CAT ASVAB	CAT ASVAB + ECAT (non-ped)		CAT ASVAB + ECAT (full)	Total Net Benefit
	A_1	A_5	A_3	A_6	A_2	A_4	A_7	A_8	
Completion Time (minutes)	100	180	135	180	100	135	180	180	
Hypothesis:									
4.4.1	4,923 (7,631)				5,379 (8,391)				456 (761)
4.4.2			5,088 (7,799)			5,670 (8,868)			582 (1,068)
4.4.3		5,073 (7,892)		5,177 (8,148)					104 (255)
4.4.4				5,177 (8,148)			5,784 (9,075)		607 (927)
4.4.5							5,784 (9,075)	6,064 (9,436)	280 (361)
4.4.6				5,177 (8,148)				6,064 (9,436)	888 (1,288)

Note. Values in parentheses are utilities adjusted by the Brogden factors appearing in Table 23.

Table 25

Present Value of Total Net Benefits (or Costs) by Fiscal Year and Research Question

Hypothesis (Comparison)	Present Value of TNB (or Costs)[1] 4.4.1 (A1 v. A2)	4.4.2 (A3 v. A4)	4.4.3 (A5 v. A6)	4.4.4 (A6 v. A7)	4.4.5 (A7 v. A8)	4.4.6 (A6 v. A8)
3.86 Years of TNB[2] Per Cohort	1,758,527,239	2,245,703,069	401,940,223	2,341,611,280	1,081,519,430	3,423,130,710
Fiscal Year (Cohort Number)						
1995[3]	(11,603,063)	(14,010,245)	0	(17,068,820)	(19,296,710)	(19,296,710)
1996	0	0	0	0	0	0
1997(1)	1,132,843,247	1,446,681,917	258,929,891	1,508,465,987	696,714,817	2,205,180,803
1988(2)	1,058,633,398	1,351,913,248	241,968,014	1,409,649,991	651,074,697	2,060,724,687
1999(3)	989,347,425	1,263,432,547	226,131,569	1,317,390,506	608,462,831	1,925,853,337
2000(4)	924,633,622	1,180,790,674	211,340,169	1,231,219,211	568,662,916	1,799,882,127
Net Present Value[4]	4,093,854,628	5,228,808,140	938,369,644	5,449,656,875	2,505,618,550	7,972,344,246

[1] Tabled values are discounted at 7% per year. See Table 16 for discount factors.

[2] Values in this row are the TNB values for one year times the 3.86 years that a the typical enlistee remains in the cohort. These are not discounted values.

[3] Values in this row are the initial setup cost (i.e., the investment cost) of the alternative hypothesized as more effective. Since we did not discount these, the present value analyses treat them as though they all occur at the beginning of 1995.

[4] The net present values in this row are column sums. These include: roughly four years per cohort (i.e., the 3.86 years that the typical enlistee remains in the military), for four cohorts (i.e., the typical number of years an ASVAB form remains in service), and the initial setup cost.

Table 26

Present Value of Total Net Benefits (or Costs)
Adjusted for the Brogden Factor by Fiscal Year and Research Question

Hypothesis Comparison	Present Value of TNB (or Costs)[1] 4.4.1 (A1 v. A2)	4.4.2 (A3 v. A4)	4.4.3 (A5 v. A6)	4.4.4 (A6 v. A7)	4.4.5 (A7 v. A8)	4.4.6 (A6 v. A8)
3.86 Years of TNB[2] Per Cohort	2,933,166,986	4,120,528,857	984,791,703	3,574,162,345	1,392,856,324	4,967,018,669
Fiscal Year (Cohort Number)						
1995[3]	(11,603,063)	(14,010,245)	0	(17,068,820)	(19,296,710)	(19,296,710)
1996	0	0	0	0	0	0
1997(1)	1,889,546,172	2,654,444,690	634,402,815	2,302,475,382	897,278,044	3,199,753,426
1988(2)	1,765,766,526	2,480,558,372	592,844,605	2,151,645,731	838,499,507	2,990,145,238
1999(3)	1,650,199,746	2,318,209,535	554,043,812	2,010,823,735	783,620,968	2,794,444,703
2000(4)	1,542,259,201	2,166,574,073	517,803,477	1,879,294,561	732,363,855	2,611,658,416
Net Present Value[4]	6,836,168,582	9,605,776,424	2,299,094,709	8,327,170,590	3,232,465,664	11,576,705,074

[1] Tabled values are discounted at 7% per year. See Table 16 for discount factors.

[2] Values in this row are the TNB values for one year times the 3.86 years that a the typical enlistee remains in the cohort. These are not discounted values.

[3] Values in this row are the initial setup cost (i.e., the investment cost) of the alternative hypothesized as more effective. Since we did not discount these, the present value analyses treat them as though they all occur at the beginning of 1995.

[4] The net present values in this row are column sums. These include: roughly four years per cohort (i.e., the 3.86 years that the typical enlistee remains in the military), for four cohorts (i.e., the typical number of years an ASVAB form remains in service), and the initial setup cost.